THE

ELECTRICAL REVIEW.

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THE

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ANTICIPATIONS.

THE strained relations now existing between this country and the United States rather precludes one from expressing an opinion as to whether next year will bring fortune or the reverse to the electro-technical interests of both nations, but it is almost beyond credence that actual hostilities will be commenced. There is too much good sense underlying the fighting instincts of both Americans and Englishmen to allow of such a contingency arising between two friendly powers; indeed, the source of disagreement seems of little more importance than that of "Harnessing Niagara," a correspondent going so far as to assert that the warlike attitude of President Cleveland is only a counter-blast to the criticism of Prof. George Forbes on the land of the free.

If, however, it is difficult to peer into the future, we can at least look upon the past year with some satisfaction, both with respect to what has been accomplished, and as a hopeful augury for the coming year.

The revolutionary schemes, the visionary ideas, taking the form of primary batteries, and certain refuse utilisation apparatus, which were to give us steam power, electrical energy, and what not, for next to nothing, have met with their usual fate, but as a set off against these there has been a growing interest and considerable advance in both secondary batteries and electric traction. Indeed, the former subject has taken quite a leading position during the last few weeks in the thoughts of Uncle Sam, while the latter has shown very significant signs of an early and extensive development on this side.

The application of oil and gas engines to tractive purposes on common roads will no doubt, under the energetic and enthusiastic auspices of Sir David Salomons, have to be taken into immediate consideration, if only for the sake of reviving the depressed state of the agricultural districts, and we trust that electrically-propelled vehicles will be found well to the front.

The utilisation of electrical energy in the form of heat for domestic purposes seems likely to remain, with the electric light, beyond the reach of the poor man; indeed, his requirements in the warmth-producing way may possibly be met in a manner which leaves but little chance for electric radiators, a suggestion for raising funds to provide oil stoves as free loans to the poor being likely to be carried out.

For a cost of less than three-halfpence, it is said that a room of moderate size can be kept comfortably warmed for nine hours. Oil, then, will be the poor man's means of heat as well as light, and electricity must, at all events for a while, be still confined to the homes of the comparatively wealthy.

Electric lighting generally will find the incandescent gas burner a more serious competitor than was anticipated earlier in the year, for very great improvements have been

made in the life and strength of the mantles, and these, again, have been wonderfully reduced in price. Nevertheless, the electric light will go steadily along, if not so rapidly as will be the case with other branches of the electrical industry, as the amended rules and regulations of the Board of Trade will no doubt remove some of the restrictions which have hitherto hindered its more extensive application, although the question of high *v.* low tension will almost certainly have to be re-opened.

One of the strongest reasons that can possibly be advanced for the adoption of electric lighting is its almost absolute immunity, when properly carried out, from the risk of fire. The following figures from the letter which Major Flood Page recently wrote to the *Times* bears eloquent testimony to the claims of electricity, and they are made more significant still, when we learn that the Phœnix Fire Insurance Office, under the experienced guidance of Mr. Musgrave Heaphy, has not had to pay one single sovereign up to the present day as loss in connection with any fire in any building lighted electrically, the installation and wiring of which has been carried out under its rules.

	1892.	1893.	1894.
Candles	175	235	157
Gas	265	284	284
Lamps	373	456	476
Electricity	1	5	3

But our strongest hopes of the future are built upon the further applications of electricity to the universal working of light railways and tram lines; to the extraction of metals from their ores; to the use of electric motors in textile factories, engineering workshops, and in the homes of working mechanics; to the cheap production of aluminium, and in metallurgy generally; to the eventual production of an ideal secondary battery, which will enable us readily and economically to store electrical energy during the period of light load, and to drive tramcars; and to many uses in connection with chemistry. It has been urged that the embryo Kelvin, Kennedy, Preece or Hopkinson, should be primarily a mechanical engineer; we would go further, and suggest that a good knowledge of chemistry will be found of equal importance to the electrical engineer of the next decade.

That some, if not all, of these anticipations will be speedily realised is our earnest hope, and we feel sure that in wishing our friends and supporters a prosperous new year, they will but re-echo our feelings.

"MADE IN GERMANY."

There are few phrases that have done more to foster national prejudices than "Made in Germany." Like a compressed beef tabloid, it contained a good deal in small compass. It summed up in a terse way a national feeling of contempt for anything German. There was certainly good reason for its adoption. It was the only way of branding the unscrupulous German manufacturer, and his still more unscrupulous English ally, as a commercial vagabond, but the phrase, unfortunately, took no note of German honesty. Previous to the year 1887, some of the staple industries of this country suffered severely from the introduction into English markets of goods bearing English names, which, however, owed their origin solely to Germany. The Sheffield cutlers were especially injured by this iniquitous system, and it was mainly on their initiative that the Act of 1862 was repealed.

The Merchandise Marks Act of 1887 is exceedingly stringent in many of its clauses. It is a Penal Act, and any person guilty of an offence against it is liable to be imprisoned for two years, and to forfeit every article which offends against the Act.

There is no doubt that the importation of German goods has many advantages. The cheap methods of production that hold in that country enable one to secure in the English market goods at low prices, and without much detriment to home manufacturers. But when an article is a direct copy of an English one, and so designed in all respects to deceive the purchaser into the belief that he is buying a home-made article, then some strong course of action becomes necessary.

It was not to be expected that in the numerous processes of manufacture involved in electrical work, we should be free from the troubles consequent on unscrupulous German competition, and of late complaints have been very numerous among British electrical manufacturers.

German made imitations of certain special English accessories are continually being imported into the home markets, and afterwards sold as English made goods. As a rule, it is very difficult to stop, and in many cases it would be hardly worth while, though it is distinctly irritating; for instance, there are certain double-pole cut-outs which, we understand, the Germans have absolutely copied, yet, although they are patented, there would be little to gain in setting the law in motion. Some companies have already taken action, but it would be obviously unfair to comment on specific cases at the present juncture.

It is to the interest of the electrical manufacturer, indeed, is of urgent necessity, to resist by every means the encroachments of our German friends. We do not complain of their rivalry when conducted openly and above board. German electrical apparatus made by reputable firms will compare with the very best, but such manufacturers do not attempt to copy English work. They have their own ideas of what is sound, and both mechanically and electrically they would be hard to beat, but the colourable imitations ought to be exposed on every possible occasion. It is not in the larger class of plant that we are likely to suffer from an evasion of the Merchandise Marks Act, it is in the small accessories such as lamp-holders, switches, cut-outs, &c.; but it is by the manufacture and sale of these that many of our firms live.

Researches on Electrolysis.

F. Oettel, whose name will at once suggest an indefatigable worker in the electrolytic fields of research, has recently been investigating the electrolysis of hydrochloric acid without a diaphragm. It is well known that on treating this acid in a simple cell an explosive mixture of hydrogen and chlorine is obtained; but the amount falls much below the theoretical yield, because some of the chlorine dissolves and recombines at the cathode with the liberated hydrogen, thus regenerating the acid. Oettel finds that this loss can be reduced by increasing the current density. He has also proved that the yield per ampère is much increased if the chlorine be rendered less soluble than in the electrolyte: this he effects by the addition of the chlorides of sodium and magnesium and the sulphate of the latter metal, but the best results were obtained by the addition of sulphuric acid; such a solution contains hydrochloric acid, sodium chloride, and the bisulphate of soda, and dissolves so little chlorine that it is scarcely coloured. In the *Zeits. für Electrotechnic und Electrochemie*, 1895, II., p. 57, Oettel gives a number of data of his experiments and illustrates them by curves.

THE PRESENT STATUS OF THE AIR BRAKE.

The *Street Railway Review* publishes a paper read by E. J. Wessels before the American Street Railway Association, calling attention to the question of air brakes for tramway work. The old hand brake is of little use for the high speed cars of to-day.

The difficulties to be surmounted by the air brake are want of knowledge of the motorman, want of space for the air compressor, lack of inspection and insufficient lubrication, the oiler neglecting the brake when he would not dream of omitting to oil the electric motor. Still, the air brake is progressing, and has already been found to be a means of saving wheels; it does not cause flat places, as the pressure can be nicely regulated.

The author states that in an extended European tour he found nothing but power brakes operated by air, vacuum, or steam, on any steam road from the North of England to Buda Pesth, and air brakes were preferred. But America is behind in the matter of brakes.

It is stated that the opposition to the electric brake has died away, and the reason adduced for this is that there is no electric trailer brake, and to be efficient a brake must apply equally to trailer cars as to motor cars, and till such an electric brake is forthcoming the air brake will hold premier place.

With cable cars, too, the brake air can be used to work the cable grips with great benefit to the life of the cable. Compulsory legislation is foreshadowed in view of the demand for better breaking powers than now exist on most roads. In the discussion it appeared that two vacuum brakes tested in St. Louis could hardly be kept at work in the city, the power being used up by too numerous stops. Mr. Wessels thinks no air brake fit to use that has not, at least, a reservoir capacity of 50 stops, and in reply to questions as to the hissing of an air brake when released, he stated that this had been quite overcome in one brake he knew. The general impression conveyed by the paper and discussion is that, so far, air brakes have not been found altogether successful in American tramway work, but that their need is greatly felt. To-day, there is not an air brake in St. Louis, although in that city they had a splendid start, and acted exceedingly well—when new. The trouble arose from cutting of packings by fine particles of dust, and, finally, the expense of leakage became so great, that the brakes were abandoned. Obviously, in the case of electrical cars, there must be some means of compressing the air other than the little steam worked pump of the railway brake or the steam ejector of the vacuum brake, and such power must come from the electric power in some way or other. There is, therefore, every reason to urge inventors to the perfecting of a good electric brake applicable to every vehicle of an electrically-propelled train, and we might point out how undesirable it is, and how opposed to general principles, that the adjuncts of a mechanical process should be actuated other than by the prime moving agent of the general machinery. One would not wisely endeavour to apply an electric brake to a steam locomotive, nor does it seem any more desirable to get up air pressure on an electric car for brake purposes.

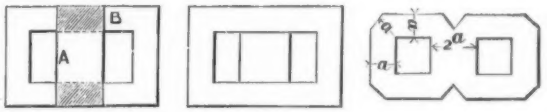
THE GEOMETRICAL FORM OF TRANSFORMER PLATES.

By GEORGE ADAMS.

In designing transformers for high efficiency, it is necessary to reduce the volume of iron used in the core to as small dimensions as possible. In most cases, however, the dimensions of the core are fixed by certain conditions of output and first cost, and the chief considerations are then to dispose the iron in the core to the best advantage, so that every portion of the iron comprising the magnetic circuit shall form a path for the magnetic flux, and avoiding the use of redundant iron.

The form of plate shown in fig. 1, in which the part, A, is stamped out of the plate, B, and placed crossways to form the transformer core, is faulty, inasmuch as it contains superfluous iron. Those portions of the plate, A, which overlap the plate, B, as indicated by shade lines in fig. 1, do not add anything to the effective area of the magnetic circuit, while they tend to increase the weight of the transformer, and consequently to augment the iron losses. The advantage claimed for this type of plate is that no metal is cut to waste, the whole being utilised to form the magnetic circuit, and the cost of manufacture is reduced accordingly.

As a set-off against this, we have to consider the fact that more iron must be employed than is actually required for the magnetic circuit; it is questionable, therefore, whether there is any real saving in first cost.

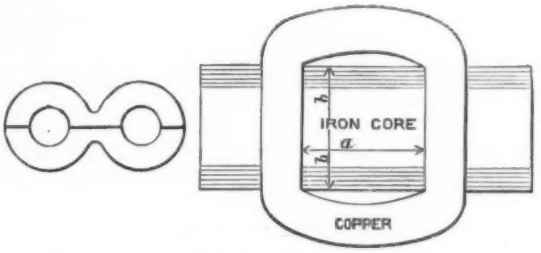


Figs. 1, 2, and 3.

A better form of plate is shown in fig. 2. In this case there is no overlapping of the plates; a transformer made up of this type of plate would consequently be more efficient than if made up of plates like fig. 1.

A form of plate which would be still more effective is shown in fig. 3. In this case the corners of the plate are cut away so that the distance (a) from the corner of the aperture is equal to the width (a) of the sides of the frame.

These corners do not add anything to the effective cross-section of the magnetic circuit, while they tend to augment the iron losses. In order to obtain the shortest length of magnetic circuit, and at the same time give the maximum



Figs. 4 and 5.

area of aperture for the coils, the aperture should be square—not oblong; as the square is by the nature of its geometrical form, the rectangular figure which encloses the maximum area for a given perimeter.

By an extension of the same reasoning, the plate shown in fig. 4 would give still better results. In this case the transformer plate consists of two annular plates joined at their peripheries.

The plates might be divided along their horizontal centre line and afterwards clamped together, when the plates are assembled to form the complete transformer.

This would be a good method of construction, as ready access to the coils could be obtained, should any repairs to the insulation be necessary.

There is no superfluous iron in this form of plate. The plates would be individually more costly than the plates shown in figs. 1, 2 and 3, but it is probable that the total cost of the iron core would not be greater, for the diminished weight of iron required would compensate in a great measure for the increased amount of metal cut to waste.

A comparison of the weights of the above forms of plate, allowing the same effective area of magnetic circuit, in each case is instructive.

Taking the area of fig. 1 as unity, the relative areas of figs. 2, 3, and 4, are as follows:—Fig. 2 = ·834, fig. 3 = ·792, fig. 4 = ·697. The weights of complete transformers having the same sectional area of core in each case, and taking W to be the weight of a complete transformer made up of plates like fig 1, would be:—

Fig. 1 = W.
„ 2 = ·834 W.
„ 3 = ·792 W.
„ 4 = ·697 W.

The weight of iron in a 10-kilowatt transformer, made up of plates as in fig. 1, working at an induction of 3,000 lines per square centimetre, was 592 lbs. The corresponding weights for the other three types, assuming the section of the core to be the same in each case, were:—

	Weight of iron in lbs.	Iron loss in watts at ~ 100.
Fig. 1 ...	... 592 ...	... 236·8
„ 2 ...	... 493 ...	... 197·2
„ 3 ...	... 470 ...	... 188·0
„ 4 ...	... 414 ...	... 165·6

The iron losses being taken at full load.

Comparing figs. 1 and 4, it will be seen that a reduction in the iron losses of 30 per cent. may be effected by a judicious distribution of the iron in the transformer plates.

The copper losses would be the same in each case, and for a transforming ratio of $\frac{2,000}{100}$ would amount to 119 watts.

The best form of section for the core of the complete transformer, when built up of plates, would be square, as in fig. 5, since the square is the rectangular figure which contains the greatest area with a given perimeter. Under these conditions, the length of the copper circuits would be a minimum for a given area of iron enclosed by them.

In the case of small transformers such as are used on distributive systems, it is of considerable importance to keep the length of the magnetic circuit as small as possible, because the magnetising current increases directly as the length of the magnetic circuit; for this class of transformer it may, therefore, be advisable to make the length, *b*, somewhat greater than *a*, fig. 5, thereby reducing the length of the magnetic circuit, although it involves a greater length of wire in the copper circuits, and consequently greater $C^2 R$ loss. The best relation between *a* and *b* can be found by trial.

In the case of large sub-station transformers the no load current need not be considered, as the transformer can be switched out of circuit by the attendant when not required. The core of such transformers may therefore be made square, provided the cooling surface is sufficiently large.

DOWN DRAUGHT FURNACE FOR STEAM BOILERS.

Our American friends seem bent on solving their smoke question by way of the down draught furnace, an idea that has been a favourite here but never attained great headway. In America the considerable use of water grates in hard coal locomotives has familiarised them with this form of grate, and it seems to present itself as a means of securing the wished for down draught, and is described in Mr. W. H. Bryan's recent paper before the American Society of Mechanical Engineers, as having rendered possible the down draught furnace with its good smoke record. We have previously described the Hawley down draught furnace as a furnace of two grates, the upper one with bars made of water tubes, and the lower grate of ordinary type, set to catch the coked stuff sliced down from the upper grate. There is thus a bright coke fire on the lower grate, and this assists in the complete combustion of all gases coming from the upper or water grate. Needless to say some air must come in between the two grates to furnish oxygen for the combustion, and it must not be thought that the water grate is very durable. With good water it should last well, but with a sedimentary water the tubes are sure to burn out. The lower grate was an after thought. The earlier Hawley furnaces had only the water grate, but much fuel fell through and was lost, and the lower grate was added to retain this, and at the same time it was the lower grate, thus applied for quite a different purpose, that made the furnace a success. As now made the water grates slope $2\frac{1}{2}$ to 3 inches per foot of length to assist circulation, and the rear ends of the tubes are not now supplied with the upturned ends and riser pipes thought necessary when the grates were horizontal, but are simply let into a transverse cylinder placed below the boiler shell with pipe connections from each end to the shell, entering the shell just below water level. This arrangement with a similar front end transverse box connected to very near the bottom of the boiler shell, seems to secure the water grate against burning off of the tube ends in such quantity as had been the case when horizontal pipes were used.

The act of combustion on a down draft grate is thus first one of distillation of the green coal, and next of the passing of the crude gases through a mass of incandescent coke on the grate. It is the action of a gas producer of limited depth supplied with too much air, and the results attained appear to show that the mixture of air and gases, much of which will be carbonic acid, are thereby sufficiently heated to burn off when supplied with a further amount of air in the space between the upper and lower grates, between two fires, which should be fairly effectual in securing the end desired. In practice about 90 per cent. of the total work is done by the upper or water grate, the lower one serving simply as a saver of the fuel which drops between the bars of the upper grate or is raked out by the slice. Tested against an ordinary grate, the Hawley grate is stated to have shown an efficiency superior to the extent of 21 per cent.

It appears that there is still more or less risk of the burning out of tubes, and there have been a few cases of grate renewals by reason of careless or ignorant use of the slice damaging the tubes by cross bending strain, and, of course, the furnace is considerably more costly than an ordinary furnace, and it cannot be used where the feed water is bad, or the boiler not accessible from the side for purposes of getting to the transverse drum; where the draught is insufficient, or the boilers hard pushed, or where there is only a single boiler, whereby a single tube failure might stop work. The furnace has the advantage of not causing serious variations of temperature when stoking, as no cold air directly passes to the flues, but though applied during the past three years to 1,600 boilers of an aggregate 240,000 horse-power, which are certainly strong evidence in its favour, the defects of the tubular grate are such that in the Thomas down draught furnace a brick grate is used, and this is anything but durable. Apart from its short life its working is excellent, but from 30 days to six months have been the limits. Even a four months' average life would be sufficient to warrant the use of a brick grate with such advantages as it secures perfect combustion in the absence of the cooling effect of the water grate. As a fact, this grate is not being pushed during the search for a thoroughly refractory firebrick, a secret, like many other genuine secrets, that will take a long time in the seeking, but which, if found, would at once solve the vexed question of smoke. Indeed, there would be no need for down draught; cover-arching of a fire, even though only partially carried out, would be all that was needed in many cases, for already, with ordinary water-cooled furnaces in such boilers as the Marine, Cornish, or Lancashire type, the problem is all but solved, and only a few additional degrees of temperature are required to secure smokelessness with economy.

Other down draught furnaces are described, one of which consists of side-by-side grates, the two outer grates being of ordinary type and the centre one alone of down draught type. On the whole, while there is no doubt that down draught furnaces will be found excellent under special conditions, and can be made to fully pay for themselves, we doubt very much their universal, or anything approaching universal, application, until, if ever, we arrive at the gas producer, which is so excellent a form of furnace, and only needs air admission to the gases produced to secure perfect combustion of these gases that are, however, more economically usable directly in the gas engine.

MOORE'S ETHERIC LIGHTING SYSTEM.

Under this somewhat fanciful title, Mr. D. McFarlane Moore describes an ingenious apparatus which he has invented for producing rapid electric waves of high tension similar to those produced in the Tesla apparatus. The air spark-gap has been used by Tesla and Ebert to abruptly start and stop a high tension current, and thereby produce short electric waves. But practical objections have arisen to this device from the fact that air becomes practically a conductor when a series of sparks are passed in rapid succession across the same gap. Insulating oils have been substituted for air by several experimenters, and by this means the abruptness of the discharge has been greatly increased, but here another difficulty has cropped up; the oil in course of time is carbonised by the electric discharge, and loses, to a great extent, its insulating power. The shortest Hertzian waves yet produced have been obtained by Prof. Rubens of Berlin by means of an oil spark gap 1 mm. in length.

Mr. D. McFarlane Moore's exceedingly novel and ingenious plan is to make his break in the circuit take place in a vacuum tube exhausted to the highest degree possible. A gap in such a tube becomes almost a perfect insulator, and Mr. Moore uses an interruptor consisting of a spring vibrated by an electro-magnet to make and break the circuit. The apparatus as arranged for illuminating a vacuum tube is shown in fig. 1.

The vibrator or interruptor tube, D, is exhausted to the highest possible degree, and contains the vibrating spring, G, with an iron armature at the free end. This armature is attracted by the electro-magnet, C, placed outside the tube, and thus breaks the circuit of the generator, A, at the point of contact, F, inside the tube. The spring is found to vibrate at a rate of four to five thousand vibrations per minute, that is, three or four times as fast as the same vibrator would vibrate in air. The rapid and powerful electric waves produced by this apparatus are transmitted

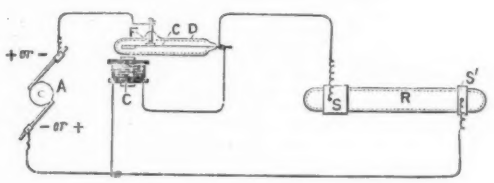


Fig. 1.

to the metallic coatings or rings, S, S^1, surrounding the ends of a vacuum tube, R, exhausted to such a degree as will give the maximum luminosity. The terminals of the light-giving tube can be connected either directly in shunt around the break, or around the terminals of the coil. Lamps containing filaments can also be operated with good results. The tension of the electric waves may be increased by making C a transformer and connecting the terminals of the primary coil to the generator, A, and the terminals of the secondary coil to the luminous vacuum tube or lamp.

Though none of the attempts to obtain light by luminescence appear as yet to have produced a light of sufficient candle-power for practical lighting, yet the efforts of inventors in this direction may at any time meet with success. We do not find, in the description of Mr. Moore's invention, any statement of the maximum candle-power which he obtains from one vacuum tube or lamp. His utilisation of the etheric gap for breaking circuit is, however, exceedingly ingenious, and will be of great interest to those engaged in theoretical investigations on Hertzian waves, if it is not of much immediate practical value. The production of electric light without heat would evidently lead to such an enormous improvement in efficiency on our present methods, that any advance in that direction is welcome.

AN AMERICAN LIGHTING SYSTEM.

In an article published by the *Western Electrician*, of Chicago, of recent date, a proposed scheme for lighting the West Side Park district, drawn up by Mr. Foree Bain, is discussed, and a somewhat lengthy extract given from his specification. The plant will have a capacity of 700 all night arc lamps of 2,000 C.P. each to begin with, and the station is so designed that the capacity can be doubled. This station confines itself exclusively to arc lighting, and becomes an almost ideal field for economical operations, the lighting being estimated at a uniform load for 10 hours per day throughout the year, and, as Mr. Bain observes, this condition of affairs is not to be compared with the corresponding expense in the ordinary conditions of lighting. On the front page of the *Western Electrician* is given a prospective elevation of the station, which, to our English eyes, presents a rustic appearance. A curious fact in connection with this artistic picture and the diagrammatic sketches on the following page, is that the artist who was responsible for the picture is evidently lacking in the elementary rudiments of architectural drawing, for to apply the picture in question to the plan given, would involve the moving of the chimney from one corner to the opposite corner of the building. The arrangement of the machinery reminds us of the early engineering efforts in central station lighting, where one or perhaps two engines were employed to drive a common counter-shaft, from which a number of dynamos received their driving power. Mr. Bain provides for sufficient boiler power contained in four boilers to supply steam to one engine, of, roughly speaking, 500 horse-power, which will transmit its power to these dynamos by means of a common countershaft. It is amusing to note Mr. Bain's alternative in the event of an accident to one of the cylinders of his engine, which is described as a compound condensing engine, each of the two cylinders being connected to separate cranks at right angles. He says there will be no difficulty in immediately disconnecting the high pressure cylinder in the event of a breakdown, and to employ the steam direct to the low pressure, at the same time obtaining equally satisfactory results by this arrangement, thereby ignoring the results which he predicts for the compound engine on account of its superior turning moment. The breakdown of the high pressure cylinder seems to be the only casualty with which Mr. Bain is expecting to have to deal, but the probability of a gross of minor accidents, each of which would render the engine temporarily unfit for commission, is entirely overlooked, and, in the event of, say, a hot main bearing, there could be no other result than the extinction of the light for an indefinite period. We may, in England, be somewhat behindhand, but we claim to be cautious, and it is not our custom to place all our eggs in one basket, but to provide for a reasonable amount of standby machinery, and we think that the arrangement referred to above of driving six dynamos from one engine without any standby whatever, is to say the least of it unwise.

It is evident that the above risks run by Mr. Bain in not supplying any reserve engine power are not accompanied by any economy in the price per kilowatt in the original outlay, which does not compare at all favourably with our English stations in this respect; indeed, many cases could be cited in which the cost per kilowatt is less than one-half of that proposed for the West Side Park Station, and it is well that Mr. Bain is not encumbered by having to provide for interest on the cost of the land or the buildings, which are to be erected on public ground.

With reference to the cost of producing the current, Mr. Bain is not at all extravagant in his estimate of attendance required for the machinery in the power house. In England, where extra high voltages are employed, it is not customary to shut up one man alone in charge of six generators producing an E.M.F. of 6,500 volts each, so that Mr. Bain's figure for attendance on the six dynamos should be doubled to represent a fair estimate of this outlay. Taking into consideration the very favourable estimates of Mr. Bain, it is found that the cost of running an arc lamp is nothing extraordinary, being as much as 41·04 dollars per year.

STORAGE BATTERY APPLICATIONS.*

The discussion of storage battery applications before the American Institute of Electrical Engineers, on Wednesday evening of last week, was opened by the reading of a communication by Mr. Arthur E. Childs, the stated object of which was to present to the Institute the main facts and considerations concerning the application of accumulators in electric generating stations, both for light and power.

It is an acknowledged fact, the author said, that the great variations and fluctuations of the load on power circuits, especially those power circuits supplying trolley lines, are among the greatest difficulties which engineers have to contend against, and any appliance which will aid them to arrive at a satisfactory running of their station is regarded with favour. It is only in the ranks of those short-sighted engineers, where ignorance and prejudice are the rule rather than the exception, that there are found men who will refuse to consider the storage battery as an auxiliary.

Mr. Childs explained that in his communication the term "variation" was used to designate the change of current produced by the adding of lights on to a lighting station, or the cars or motors on to a power station, and the term "fluctuation" was used to indicate those rapid and necessary changes of current taking place on the outside line, due to stopping or starting of cars, or throwing on or off of stationary motors. By the "type" of battery, he said, is meant the slow discharge battery for a long period of service, or the rapid discharge battery for a few hours, or even less time of discharge.

In the lighting station, he continued, if we bear in mind the usual form of curve, it will be remembered that the instantaneous changes of current are minute and almost imperceptible compared with the steady increase or diminution of the total current of the station. Comparing the lighting curve with the usual form of power station curve, it will be noticed that the instantaneous changes of the current are enormous compared with that in the lighting station curve. There is a similarity in the two curves in the fact that at certain hours of the day more cars are operated than at other hours, thus producing a general rise in the level of the power curve corresponding to throwing on of a number of lights in the lighting curve.

The introduction of a storage battery into a central station acts in a certain sense as a buffer between the external load and the dynamos, taking the shock of the variations without throwing the same on the engines, and has the effect of reducing the average percentage variation in load on the dynamo from a large amount to a very small one, making the operation of the machines more efficient. In fact, a storage battery acts as a regulator in this instance, maintaining as it does a constant voltage at the switchboard. This introduces the question of the efficiency of engines with varying loads; and, leaving out of account the reports by engine builders, who are naturally interested parties, it is a fact that not many extended and careful investigations of efficiency under varying loads have been carried out. Prof. W. C. Unwin, of the Central Institution, at South Kensington, has shown, however, that a decrease of mechanical efficiency has a serious effect on the economy of working with a variable load, and with a load varying from 100 per cent. to 25 per cent. the efficiency decreases from 85 per cent. to 40 per cent.

As applied to power stations, and especially where water power is used, the author considered storage batteries almost indispensable, and said he knew of several plants where the successful maintenance of a constant voltage on the machines is dependent upon the fact that an attendant sits by the governors of the wheels and regulates them by hand, the best water-wheel governor that has ever been produced not being capable of satisfactorily meeting the rapid changes in load. The stations in mind, he continued, are not small stations, as might be supposed at first thought, but are stations where several thousand horse-power and over are generated at certain hours of the day; and it is surprising that engineers of intelligence are still allowing their prejudices to prevent them from investigating the merits and value of accumulators as regulating governors in their stations.

Mr. Childs mentioned the advantages to be obtained by the use of accumulators in railway power houses to straighten out the enormous fluctuations in load, and also referred to the application of storage batteries to illuminating plants, mentioning as notable instances the New York Edison Illuminating Company, the Edison Illuminating Company of Boston, and the Lawrence Gas Company, Lawrence, Mass. In the latter case, he said, the battery is used in connection with the Edison three-wire system for carrying the peak of the load during the busy hours of lighting, and the entire load at noon, when the large mills on the Merrimac at Lawrence shut down, backing up the water into the river above, and entirely cutting off the supply to the wheels of the gas company, for some 25 or 30 minutes.

The storage battery can also be used, he said, as a valuable adjunct to both power and lighting stations at points in their systems where it is difficult to maintain the voltage at periods of heavy load. In these cases the feeders are usually not sufficient to carry the whole current direct to the station, but during the periods of small load the feeders can be utilised up to their maximum allowable drop in potential to charge battery sub-stations placed at these weak points. When the load at such points becomes greater than the capacity of the feeder, the battery comes into play and carries the load in connection with the station supply at that point, thus maintaining the voltage and doing satisfactory and valuable service.

Referring to the use of accumulators in Europe, he pointed out the fact that more than 20 lighting stations, and several thousand isolated plants in Great Britain alone, and in Germany 5,000 isolated plants and 15 railway power plants, are using storage batteries. In fact, he continued, 80 per cent. of all the central stations in Germany and Austria are equipped with storage batteries. In addition to the above, there are many stations in France, Italy, Holland, Belgium, Sweden, Norway, Denmark, and Spain, and two or three in Switzerland.

One point which has contributed largely toward the success of storage batteries in Europe is the fact that engineers have endeavoured to obtain long life and high efficiency even at the expense of increased first cost, and instead of attempting to obtain a large output per pound of element, they have limited themselves to a reasonable number of ampère-hours per pound. The result of this has been that the batteries in use in Europe have shown great endurance and solidity. The experience, however, which has been obtained with many American batteries has not been so promising as on the Continent, owing to the lack of proper appreciation of them. It would be greatly to the advantage of American engineers if they would follow the lines laid down by their European *confrères*; and if, instead of waiting for some marvellous development in the manufacture of storage batteries, they should make use of the existing high class and efficient batteries, and by using them in a reasonable manner they would obtain valuable, and even remarkable results.

Considering the efficiency of a storage battery, the author said the factors would tend to reduce it—loss in voltage and quantity of current—are not so serious as they have been in the past, and manufacturers are at present able to guarantee a very high efficiency. In cells which were submitted to Prof. H. L. Callender, he stated, an ampère efficiency of 96·1 per cent. was recorded, the watt efficiency being 84 per cent. In certain instances, however, known to the writer, these efficiencies have been slightly exceeded, and complaints from central station managers that they cannot obtain efficient cells are now groundless, as with the efficiencies named, an eminently satisfactory service can be obtained. It must be borne in mind that a loss of 16 per cent., or even 20 per cent. in the efficiency of the battery does not mean the loss of the same percentage in the output of the station, as the battery usually supplies, approximately, or even less, of the whole output in watt-hours, and it is, therefore, from that fraction of the whole output that the loss in the battery must be deducted.

Concerning the matter of cost of maintenance of a storage battery outfit, Mr. Childs stated that it is now usual for the manufacturer to guarantee a fixed annual percentage, varying from 10 per cent. in small plants to a smaller percentage in large plants, depending, of course, on the conditions of operation and the use to be made of the battery, a study of which will soon determine what percentage can be guaranteed. In first-class plants, well installed and operated by careful engineers, the cost of maintenance can be reduced to the vicinity of 3·5 or 4 per cent. It is customary for the manufacturers to enter into a contract, in the case of large plants, guaranteeing that the cost of maintenance shall not exceed a certain percentage per annum for the period of contract. This can be carried out in two ways. Either the lighting or railway company can pay the manufacturer the percentage specified, every year, and the manufacturer will inspect and keep the battery in first-class condition, or the company employing the batteries can inspect and order renewals themselves, in which case should the cost of maintenance exceed the percentage guaranteed, the manufacturer will not charge more than the specified amount. This is an exception rather than the rule, however, as the cost of maintenance is usually somewhat lower than that specified by the manufacturers, so that the company owning the battery is the gainer, by the difference in percentage. By a thorough attention to details, both large and small, the percentage can be kept down to a very low figure; and it is to be regretted that the practice of engineers which prevails in Europe of treating the battery with care and consideration does not seem to exist among the engineers of this country, to the detriment of their own lighting or railway plants.

It must not be assumed from the above, he continued, that storage batteries require an inordinate amount of care and trouble. On the contrary, they do not require either great expense or care. All that is demanded is regular and systematic attention on the part of those having them in charge. When such care is exercised, it is found that batteries perform a very valuable service, and largely reduce the operating expenses of the station—in many cases as much as 30 to 35 per cent. This reduction in operating expenses is, of course, due to the saving in cost of coal consumed, a saving which could not otherwise be obtained. Where water-power is employed, a storage battery enables the water-wheels to be operated for 24 hours, storing current while the station output is reduced to a minimum, and aiding the station during the busy hours of the day. In many cases this practically doubles the output of the station without increasing the cost of installation to a corresponding amount. In many cases where water-power is used it would be impossible to double the generating capacity of a station, as there would not be enough water at hand to give double the power. This is especially true in those sections of the country where the power of small streams has been utilised, and where the flow of water is continuous but not very great. In addition to the action of the storage battery as a receiver for storing the current while the station is not giving a large output, it also maintains, during the operation of the station, a perfectly uniform voltage which would not be obtained with the varying load direct upon the water-wheels, on account of the difficulty in governing previously mentioned.

When an entirely new power-plant is to be built, the writer had no doubt that by adopting the storage battery in the first instance, the initial cost of installation would be less than for the plant not using storage batteries, and the cost of operation of the station will certainly be much reduced when the station uses storage batteries. In the case of existing plants which have to be extended, it has been proved that a kilowatt-hour capacity can be added more cheaply to the station by the addition of storage batteries than by the addition of generating machinery; while, of course, the cost of operation is much reduced.

* New York *Electrical World*

Referring to the primary cost of storage batteries, he stated that the cost per kilowatt-hour output is relatively greater for small cells than for large ones, since the cost of manufacture is reduced per kilowatt-hour in the larger sizes, whereas the jars and tanks which are used to hold elements do not decrease very much with the decrease in size of the elements. The cost of shipment and erection are, of course, slightly less per kilowatt hour with the larger sizes than with the smaller ones, and, on the whole, the cost per kilowatt hour with the larger cells is less than with the smaller sizes. It is stated by the Electric Storage Battery Company that it is now installing large plants of Tudor type at a cost per kilowatt hour of about $37 to $40, which cost, it is understood, can be reduced in the larger stations. The question of cost, however, he concluded, is one which must be studied out in each case where it is proposed to instal storage batteries.

Mr. Childs's communication was followed by one from Mr. C. L. Edgar, presenting his experience with accumulators in connection with the large direct current incandescent lighting station in Boston.

Mr. Edgar assumed, at least for the purpose of this communication, that the perplexing questions which had so long involved storage battery construction had been disposed of, and that engineers in this country were now on equal ground with those across the Atlantic. He thought that the uses of accumulators might be classed under four principal heads, namely:

1. *To carry the peak of the load.*
2. *To carry the entire load at minimum hours.*
3. *To act as an equaliser or reservoir.*
4. *For the equipment of annex or sub-stations.*

Referring to the use of batteries for carrying the peak of the load, he called attention to the fact that in all lighting plants there is a considerable part of the load which is present during a very small portion of the day — about two hours — during the winter months. This is due to the fact that a great many stores close at 6 o'clock in the evening and do not require light after that time, but do need it from dusk (which comes about 4.30 during the months referred to) until closing time. The presence, he said, of a large day load of motors, or a large night load, as of street lamps, did not affect the peak further than to change the height of the curve at those hours. Mr. Edgar thought it safe to assume that the peak of the load would represent from one-third to one-half of the total maximum load of a station, and stated that the company with which he is connected had found that one-half of the maximum load on the plant existed for about two hours per day ordinarily, and four hours under exceptional circumstances for the five winter months, and that the energy in kilowatt-hours generated for this short period demand represented only about 10 per cent. of the total number of kilowatt-hours for the year, 90 per cent. being steady load. This result, he said, went to prove the position taken by some engineers who had declared that a very large station could profitably be equipped with two types of apparatus, one half to be of the very best obtainable, and the other half cheap and comparatively inefficient, but reliable machinery, the high grade equipment to handle the steady load and the cheap apparatus, the intermittent or "peak" load. The object in this would be the saving in interest on the cost of the cheap apparatus, which, he stated, exceeded the greater cost of operating this apparatus, because of the small proportion of the working hours during which it would be in use. Mr. Edgar considered that the application of storage batteries in such a case was obvious, and his company had installed them to meet the conditions specified—namely, to take care of the peak of the load.

Discussing the second head, *Carrying the entire load at minimum hours*, Mr. Edgar thought that the nature of the load curve in America was against the use of accumulators for this purpose, the period of minimum load being too short to save a shift of men, or to save very much by banking or drawing fires. Experiments made by his company had demonstrated that running the engines 24 hours a day, charging the batteries during minimum load hours, and having them take the peak during maximum hours, was more economical than shutting down the engines and carrying the load with the batteries during minimum hours.

Considering the storage battery as an equaliser or reservoir, the writer said his company had been particularly pleased with results obtained from the use of accumulators in this manner. It enabled one to foretell just what the load would be, and eliminated the necessity for starting up or shutting down generating sets as the load increases or falls off. His practice was to keep the battery constantly connected up with one or another, or all bus-bars, where it may be called upon at any moment to give or receive anywhere from 1 to 3,000 ampères, and he had found it practical by this means to operate the engines at never less than three-quarters load. He had found that the losses in the battery are compensated for more than four-fold by the increase in steam economy, and thought it impossible to over-estimate the advantages of storage batteries for imparting reliability and furnishing regulation to a distributing system.

The use of accumulators for the equipment of annex stations, the writer stated, had not been practically investigated by his company, but he thought storage batteries would be particularly advantageous where the generating station could be located on some near-by water front, and small distributing stations scattered throughout the city, the distributing stations being equipped with accumulators. In closing, Mr. Edgar said that his communication was intentionally written upon somewhat narrow lines, because so much had recently been written upon generalities, that he deemed it advisable to brush these aside, and confine himself to specific cases.

Mr. Nelson W. Perry then read a communication, the title of which was, "Storage Battery or the Gas Engine as an Auxiliary." *

A communication by Prof. F. B. Crocker was then read by the author. Mr. Crocker's communication covered very much the same subject-matter as was discussed by Mr. Edgar's communication, and the author therefore omitted in the reading such parts as duplicated parts of Mr. Edgar's paper.

Prof. Crocker divided the principal uses to which accumulators may be put in electric lighting into the following classes:

1. To supply portable electric lamps.
2. To take up fluctuations and thus steady the voltage or current.
3. To furnish energy during certain hours of the day or night and enable the machinery to be stopped.
4. To aid the generating plant in carrying the heavier load, which usually exists for only an hour or two.
5. To make the load on the engines more uniform by charging the battery when the load is light
6. To transform from a higher to a lower potential by changing the battery in series, and discharging it in parallel, or *vice versa*.
7. To sub-divide the voltage and enable a three or a five-wire system to be operated with a single dynamo.
8. To supply current from local centres or sub-stations.

Each of these applications he considered separately in the above order.

1. *Portable Accumulators.*—The accumulator, the author stated, is practically the only means of supplying electric portable lamps or those which are not connected to a dynamo even if they are stationary. The serious drawback with portable accumulators is their great weight. For example, a standard size which weighs 100 lbs. yields 10 volts and 5 ampères, or 50 watts for 10 hours, which is just sufficient to feed one ordinary incandescent lamp of 16 C P. This weight would be prohibitive in most cases, in which the only way to carry the battery was by hand, but it might be allowable for lighting railway trains where the weight would not be so objectionable.

2. *Accumulators for preventing fluctuations*, due to unsteadiness in the driving power, are often applied successfully. A dynamo driven by a gas engine, for example, may vary periodically in speed because of the explosive action of the gas in the cylinder, and a battery connected in parallel with the dynamo will have the effect of steadying the voltage. But improvements in design and construction, he continued, tend to reduce unsteadiness of speed, and by the use of a heavy fly-wheel and an elastic connection between the engine and dynamo, the result is sufficiently satisfactory in most cases to make a battery unnecessary. An accumulator is generally installed in connection with a small gas engine lighting plant to enable the engine to be stopped for a considerable portion of the time and save labour and attention, in which case the battery may also act to prevent fluctuations, but its principal function is the former one.

3. *Accumulators to enable machinery to be stopped during certain portions of the day or night.*—The advantage of this application depends upon the fact that in almost every electric lighting plant there are long periods during the day and late at night when the number of lamps lighted is so small that it may not pay to run the generating machinery.

This plan also allows the machines to rest and cool down, which greatly facilitates cleaning and repairing. In a hotel, residence, or on board of a yacht, it may also be very desirable to stop the machinery and avoid the vibration and noise during the night. On the other hand, the addition of an accumulator to an electrical plant renders the latter heterogeneous, since the battery and its management differ so radically from the machinery and the handling of the same. It must also be remembered that the total investment is increased by the cost of the battery and its accommodation, because the generating plant is perfectly able to carry the load put upon the battery since, by hypothesis, this load is a light one. Hence the machinery might be run all the time, in which case the battery would be entirely unnecessary, and sufficient rest of the machinery could be secured by using different machines for the periods of light load on successive days. These statements are based upon the supposition that the battery is not used to help the dynamos at the time of maximum load, since this case was considered separately.

4 and 5. *Accumulators to aid in carrying the maximum load and accumulators to maintain uniform load on the engines.*—As Mr. Edgar had covered these cases so thoroughly, Prof. Crocker passed on to the next class.

6. *Accumulators used as transformers.*—The writer pointed out that if the cells of a battery are arranged in series while being charged and in parallel for discharging, a high-voltage current will be required for the charging, and a low-voltage current will be given out, but the total amount of energy measured in watts is the same minus the loss of 15 or 20 per cent. which always occurs in accumulators. Such a method of transformation of potential, he suggested, might be employed in connection with long-distance transmission of energy, the current being sent over the line at high voltage, and converted to low voltage by accumulators for local distribution. For potentials of several thousand volts, which are commonly employed in transmitting long distances, the number of cells required would be so great as to make this of doubtful practicability compared with the ordinary stationary or rotary transformers, but it would give uniformity in load and other advantages which may be secured by the storage of energy.

7. *Accumulators used for sub-dividing voltage.*—This application is similar in principle to the preceding. The most important practical case is that in which a dynamo of 220 volts charges a battery of corresponding potential and a three-wire system is supplied from the battery, the neutral wire of the circuits being connected to the middle point of the battery. This arrangement would avoid the necessity of running two dynamos and allow the battery to be placed in a sub-station near the districts to be supplied, so that it would only be necessary to run two conductors to that point instead of three. The same principle may be applied to the five-wire system.

8. *Accumulator sub-stations.*—The installation of battery plants at local centres which are charged from the main station, would enable some of the conductors to be saved in a three or five-wire

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* This was referred to in our leading columns last week.—EDS. ELEC. REV.

system, as already stated. It would also make it possible to reduce the size of these conductors, because the current which flows over them could be kept practically constant, so that it would not be necessary to have them large enough to carry the maximum current consumed by the lamps, which may be several times the average value. This, of course, would give the same steady load on the generating machinery as if the battery were located near it.

Accumulators used for two or more of the above-named purposes.—Each of the different uses of the storage battery, the author stated, had been considered separately to avoid the confusion with which this subject is often beset, but as a matter of fact the employment of the accumulator for several of these purposes is the most common practice. As Mr. Edgar had stated, the combination of these different applications rendered a plant not only more economical, but also much more flexible. For example, the battery may be utilised to help out the generating machinery at times of heavy load or when the latter is partially or wholly disabled. It often happens that it is difficult to produce or maintain sufficient steam pressure, owing to poor draught or other circumstances, in which event a battery enables the boilers to be temporarily relieved of some or all of the drain upon them while the pressure is being raised to the proper point. It may also be necessary or desirable to shut down the machinery, or a portion of it, for a few minutes, to make some repair, adjustment, or change of arrangement, connection, &c.

It is also possible to feed some of the circuits from the battery while the others may be supplied at a higher or lower voltage by the machinery. In these and many other ways an accumulator may be a very convenient adjunct to an electric lighting system. The fact that it is so radically different from the machinery in its nature and action makes it very unlikely that the entire plant will be crippled at any one time, since the two sources of current are not exposed to the same dangers. An accident to the steam piping, for instance, might shut down all of the machinery, but it probably would not affect the battery, and *vice versa*, an accident to the latter is not likely to extend to the former.

Mr. Carl Hering then read a communication entitled, "Past and Present Obstacles in Storage Battery Development."

Mr. Hering, in his remarks, said that the question which the engineer and constructor should discuss at present is not "Is a battery desirable?" but rather "Why is it that storage batteries seem to have been unsatisfactory?" and the question which concerns the capitalist is: "Does it pay in dollars and cents to use the storage battery, even if it is kept in a satisfactory condition by the makers?"

The latter question, he said, can be disposed of in a few words. If the makers guarantee to keep the battery in a satisfactory condition for a certain rate per annum, or if they rent them, then it becomes a mere matter of calculation for each specific case to find whether it pays or not. In some cases it will be found to decidedly pay, in some it will be doubtful, and in some decidedly too expensive. Limiting ourselves to this country, and judging in a general way from a number of storage battery installations, it would seem that the price at present (including, of course, the cost of maintenance) is such, that in perhaps the majority of cases the margin of profit to the user is so small or so doubtful, that it does not balance the supposed risk, The commendable practice of renting relieves the purchaser of this risk, which then leaves the question a mere matter of cost. A material reduction in the first cost and cost of maintenance would therefore at once turn the tables in many cases so decidedly in favour of the storage battery, that there would be little doubt left as to the economy, and it would render the practice of renting necessary in most cases. Cheapness, therefore, is one of the most important points which affect the outlook of the storage battery.

Returning to the first question, "Why is it that storage batteries seem to have been unsatisfactory?" Mr. Hering said that condition applied only to this country, as probably thousands of tons are, and have been in successful use abroad. In Germany, for instance, almost everyone of the large continuous current central stations is equipped with a battery plant; in England they are used very largely for private plants, as also for central stations, and an English firm recently claimed to have sold a total of "six miles" of accumulators, placed in one continuous row, and a French firm is stated to make several tons a day.

The chief reason why so few storage battery plants exist in this country, he thought, was that the accumulator companies have for years been so busy fighting each other's patents, and have spent so much money in this litigation, that they have had neither time nor money left to manufacture and instal their batteries. But all this litigation had now come to an end, and this, together with the fact that many authorities now concede that for many, if not most purposes, the unpatented Planté type of cell is the better, removes the chief obstacle in the storage battery development in this country.

Mr. Hering enumerated the chief diseases of the accumulators as follows:—Buckling, short-circuiting, sulphating, disintegration and dropping out of the peroxide. Many inventors, he said, have thought that most of these may be cured by a process of opposing or resisting their disastrous effects as distinguished from preventing their occurrence. Buckling has been opposed by main strength, short-circuiting by porous insulating sheets between the plates, falling out, by inclosing or locking the peroxide so that it cannot drop out, &c. Mr. Hering doubted the efficacy of these methods, and considered that to attempt to prevent the almost irresistible force of expansion of the peroxide from exercising itself by confining the material in an inelastic frame is a formidable and almost hopeless task. The inevitable result is, that one or the other must give way; if it is the peroxide, it will ultimately be crumbled by the pressure; if it is the lead, there will probably be buckling, or, at least, a separating of the contact surfaces at the subsequent contraction of the peroxide, and this inevitably results in the formation of that very objectionable layer of white sulphate which practically insulates the active material from its conductor, the consequences of which are sure to be fatal. The development of the storage battery has also, he considers, been greatly retarded by the fact that it was in the hands of mechanical engineers instead of chemists.

The careful constructor, Mr. Hering thought, should attack the problem in a different way, and a satisfactory one would be to construct the plates, if possible, so that the prime causes of trouble cannot arise, no matter what mistakes the attendant make, or what emergencies the battery may be called upon to meet within reasonable limits. The chief evil effects are apparently caused by too rapid charging and discharging, and what should be done is to try and construct the plates so that they are adapted to high rates without a great loss of efficiency or capacity. The ideal method would seem to be a vertical lead plate to act as a good conductor, with an extremely large surface and a very thin layer of peroxide on it, freely exposed to a large quantity of acid, which is capable of circulating rapidly. That such a plate may be made to have a far greater capacity per pound of plate for rapid discharges, and at least equal for slow discharges, as compared with the best thick, porous plate, has been shown by experience. The great capacity is doubtless due to the fact that the active material is more completely utilised, as it is all close to the conductor, and freely exposed to the acid. The capacity of such a plate will evidently be effected only slightly by the rate and the loss of voltage, and therefore the watt efficiency will depend more on the conductivity of the lead than on the acid becoming too dilute in the immediate neighbourhood of the active material. To obtain high rates, accompanied by good efficiency and capacity, there is little doubt that the best way is to use large surfaces rather than to try to resist the evil effects of high rates mechanically.

In rapid charging, the acid becomes too dense in the pores of a thick mass of active material if the circulation does not keep pace with the demand; this dense acid softens the peroxide, and there is a tendency to form gases when the proper chemical action cannot keep pace with the current. Both the softening and the mechanical effects of the gases are injurious. What was said regarding porosity and the ideal plate applies therefore also to the charging. The negative plates being soft and tough, are not so easily injured, but unless the acid can circulate very freely, there will still be a lowering of the voltage like with the positive plates, and probably also a lowering of the ampère-hour capacity.

The contact between the peroxide and its conductor must be very good, for, if poor, then a white sulphate forms at the surface, which practically produces an insulating layer, and disastrous effects are then inevitable. The ideal contact is obtained when the peroxide is formed on the lead electrolytically, as in the Planté processes.

The peroxide will insist on expanding during the discharge, and on contracting during the charge. It would be much better to accept this as an inevitable fact than to try to keep the material from obeying the laws of nature by forciby confining it within an inelastic frame. The best solution seems to be to have the active in the form of an extremely thin layer over a large surface, and formed from the lead itself, as this increases its adhering properties. If such a layer can be made porous, and if the surface is made up of small facets, there will be little tendency to buckling or scaling.

The gradual washing away of the surface of the peroxide, and the slow peroxidation and consequent disintegration of the lead support, seem to be absolutely unavoidable; but there is one way of meeting the difficulty, which has recently been applied, and which seems to be a much more rational and effective solution of this vexed problem, at least when lightness and smaller first cost are desired. Instead of making the positive plates heavy and expensive, they may be made very light, cheap, and easily replaceable; their life may then be shorter, but the battery will be as good as new whenever these perishable parts have been renewed; their life is soon known to the user, and he can readily then determine for himself how much he must allow for amortisation. Such a method, to be successful, requires that the old plates and sludge be converted at a small cost into new plates; this, it seems, can now be done, and Mr. Hering believes that this alone will have a very important bearing on the outlook of the storage battery, at least for portable cells, such as are required for traction and many other purposes, or for both portable and stationary plants if the first cost is an important factor. Such a method becomes practicable only when the chief factor in the cost of the plate is the material, the cost of labour and forming being small.

For stationary purposes, in which the only objection to the weight is the first cost of the lead, good storage batteries have been used abroad with success for some time, provided the rates of charge and discharge are kept low; but this is not true of batteries for accumulator traction, which Mr. Hering states is the ideal system, as has been repeatedly acknowledged by good authorities, and he considers it probable that this field for batteries is very large, and perhaps larger, than that for stationary work.

For this very trying work, he believes the only batteries which have a promising outlook are those which have a very large surface, very small depth of active material formed electrolytically, and a very free circulation of the acid. The lead frames should be made only thick enough for proper conduction, the batteries must be cheap in first cost, and the positive plates should be capable of being replaced comparatively frequently at small cost. They should be proportioned so that a discharge corresponds to one trip of the car—and only one. To claim as an advantage that a battery can run a car, say, four trips, is mere deception, and to the intelligent engineer it is simply an admission that it can do no better. No one would think of carrying four relays of horses on a trailer of a horse car, and why, he asks, should the equivalent be done with the storage battery unless it is that the battery can do no better, and that it cannot be discharged rapidly enough so that the capacity and weight may be reduced to that required to run only one trip? The ideal, Mr. Hering considers to be a single-trip discharge. If the rate for a four-trip battery could be increased four times without materally affecting the

capacity, its weight and capacity for a single-trip discharge would evidently need be only one-fourth as great. The charging rate should also be equal in hours to the mean discharge rate, or else it will take a plant of more than two sets of batteries to a car.

Mr. Hering summarised his discussion as follows: Cessation of litigation and the development of the Planté type of cells make the storage battery outlook in this country much brighter; the cost of a guarantee storage battery seems in many cases to be too nearly equal to that of the direct generators to encourage their general adoption. A reduction in the cost would therefore open a large field, much larger than in proportion to the reduction; the renting of accumulators seems a commendable method for introducing them. Most of the diseases which storage batteries are subject to could be avoided or made much less disastrous by having large surfaces, small depth of active material and free circulation. The first cost would be reduced and the vexing question of the uncertain amortisation settled, by a light, short-lived, cheap, positive plate and a cheap process of reconverting old into new positive plates. Storage batteries for slow discharges have been a success abroad; a very large additional field would be opened by a light, cheap, rapid-rate cell.

The objection to a plate with a thin layer of active material is that it may not retain its charge as well as one with a thick layer or pellets, but in most cases in which rapid rates are desired, or cannot be avoided, the small loss in standing is probably more than balanced by the fact that the plates are not injured by rapid rates. As a rule, long periods between charges go hand in hand with slow discharges and less objection to great weight, while short periods between charges, high rates of discharges and lightness, usually go together.

In conclusion, Mr. Hering made the following recommendations in the interests of engineers who may have to calculate accumulator plants.

That rates of charge and discharge be designated in *hours* and fractions, the current (or for power purposes, the watts) during that time being considered to be kept constant. There can then be no mistake as to what is meant, as this represents the time in hours during which a cell will continue to give a practically constant current before the voltage falls below its limit. That efficiencies and capacities be always accompanied by the corresponding rate in hours. That in giving an efficiency it should always be stated whether it is for ampère hours or watt hours. That for portable batteries intended for power purposes the capacity be given in watt hours instead of ampère hours, and that the weight given be that of the complete cell ready for use, as distinguished from the weight of the plates alone.

A short communication was next presented by Mr. Reckenzaun, who stated that owing to the fact of his absence in Europe, from which he had only just returned, he had not had sufficient time to prepare a more comprehensive paper.

THE DISCUSSION.

Mr. Wolcott expressed the opinion that Mr. Edgar's paper was exceedingly timely and important, in that it presented an account of what had actually been accomplished in practice, and did not theorise as to what might or might not be accomplished. Referring to Mr. Perry's figures on the consumption of gas by gas engines, Mr. Wolcott thought that 15 cubic feet per horse-power-hour was an exceedingly low figure, and expressed his doubts as to whether such results were possible. Mr. Perry replied that he had merely given 15 cubic feet as the figures which were claimed by some manufacturers, but thought that he had explicitly stated that in practice a figure of 17 or 18 cubic feet was the most economical so far obtained; in figuring out the results given in his communication, he had based his calculations upon the consumption of 25 cubic feet per horse-power-hour.

Mr. Edgar, referring to Prof. Crocker's proposed use of accumulators as transformers, charging them in series and discharging them in multiple, said that the objection to such practice was that the same mains could not be used for charging and discharging the accumulators, whereas if the accumulators were charged at about the potential of the lighting mains, the dynamos and accumulators could both be connected with the same mains at all times if desired. Concerning the comparative cost of accumulators and a regular generating plant he stated that his company has just had installed accumulators at a cost of $50,000, of the same capacity as a steam and dynamo plant which would cost $65,000, its capacity being reckoned in kilowatts, of course, and the batteries had a guaranteed efficiency of 75 per cent. Referring to the matter of depreciation, Mr. Edgar stated that the European company which had furnished his accumulators guaranteed a depreciation not exceeding 6 per cent., and that the same company's practice in Germany was to make a 4 per cent. guarantee, of which 75 per cent. of its customers declined to avail themselves, because results showed that their depreciation did not exceed 3 per cent.

Mr. H. Ward Leonard called attention to the application of storage batteries for the regulation of the speed of motors used in elevator and kindred service. He regarded patent ligitation merely as an excuse, and expressed the opinion that the reason storage batteries had not come to the front more rapidly in this country was that no meritorious battery had hitherto been produced. He stated that he had installed a great many dynamos and a considerable number of accumulators during the past 10 years, and while all of the dynamos installed were still in use and giving good service, not one of the storage-battery plants had survived. "This may be because I put them in," he added. Referring to the comparative cost of a storage battery and a steam and dynamo plant, he thought that in making such comparisons, the cost per kilowatt capacity of an engine should be based upon the *maximum* safe capacity of that engine, and not upon its rated capacity. He said that he did not agree with Mr. Edgar that a storage-battery plant was cheaper than a steam and dynamo plant of the same capacity in watts. He had never been able to buy batteries at less than $160 per kilowatt capacity, operated at their guaranteed rate, and even Mr. Edgar's figure of $120 per kilowatt capacity, was not cheaper than a steam and dynamo plant. Mr. Edgar replied that the element of overload for storage batteries was about equal to that of a steam and dynamo plant, and that the cost per kilowatt capacity of the former was based on about the same load as for the latter.

Mr. Entz, referring to the matter of depreciation, said that for the last year he had been in and around the Tudor factory in Germany, and that all the engineers he met in that country agreed with Mr. Edgar as to depreciation. He said that the practice of the company manufacturing the Tudor battery was to guarantee a battery irrespective of its discharge rate, and that it had made money on its 4 per cent. guarantee.

Mr. Blizard expressed the belief that it was impracticable to operate gas engines driving large dynamos connected in parallel, which would be necessary in order to take care of the peak of the load with gas engines in a large station, as proposed by Mr. Perry. He also stated that American gas engines very nearly approximated the efficiency of those of foreign makes, and referring to Mr. Perry's statement as to the extensive use of the gas engine in European central stations, he called attention to the fact that there were very few of those stations which did not use accumulators in connection with the gas engines. He expressed the opinion that previous storage battery practice had been wrong, in that manufacturers had not considered the specific conditions under which batteries were to be used.

Mr. E. T. Birdsall thought that the trouble with storage batteries had been that the batteries so far installed were invariably too small for the work to be performed, and stated that he had recently displaced a plant of 300 ampère hours capacity with one of 800 ampère hours capacity, which was not made larger because that was the biggest one his customer would buy. If he had had his way, he said, he would have made it a 1,600-ampère plant.

Mr. Appleton criticised Mr. Perry's proposition of running gas mains to an annex station for the operation of engines at that point, and thought that as the copper conductors were there anyhow for distribution purposes, they might as well be used for transmitting current to the sub-station. Mr. Perry replied that the object in using the gas mains was to render unnecessary the copper conductors, and that it was not his proposition to have both gas pipes and copper wires extending from the main station to the sub-station.

Mr. Childs criticised Mr. Hering's suggestion that the best practice for railway work would be to have a car equipped with a battery which would only last through one trip, and asked Mr. Hering what he meant by one trip. Mr. Hering replied that one trip was the work of a car from the time it left the power house until it got back again, and said that he thought that this was so obvious that it needed no explanation. Mr. Hering again called attention to the fact that there was much confusion in the rating of accumulators, and thought that when prices and capacities were given the discharge rates should invariably be stated also.

Mr. Lieb took exception to Mr. Hering's statement that one of the troubles of the storage battery was, that it had been left too much in the hands of mechanical engineers, and had not received sufficient attention from competent chemists. Mr. Lieb thought that what success the storage battery had so far attained was almost entirely due to the work which had been put upon it by mechanical engineers.

Owing to the lateness of the hour, the discussion was here declared closed, and the meeting adjourned.

THE ARCHBUTT-DEELEY PROCESS OF WATER SOFTENING.

SINCE the purification of water containing lime salts in solution was first performed, about 1841, by the well-known Clark process, numerous types of apparatus have been employed to carry the system into effect. One of these, which is distinguished by the addition of an extra detail, is that of Messrs. Archbutt and Deeley, whose apparatus is being used to soften some 30,000 gallons hourly at the Midland Railway works at Derby. The basis of most water-softening processes is the fact that lime carbonate is almost insoluble in water, but lime bicarbonate is soluble. It is the bicarbonate that is the chief scale-producing factor in most hard waters. Sulphate of lime is also about on a par with carbonate, and in some districts exceeds the carbonates, while about London the carbonate is the principal lime salt. Then there is carbonate of magnesia, whose water hardening power is on a par with the similar calcic salt. There are also chlorides of soda and magnesia, and other salts of soda not amenable to ordinary treatment, but being very soluble, they may be allowed to collect until sufficiently saturated to be blown out. The two principal salts of lime, however, are the great scale formers, the first being precipitated at 212° F., because at that temperature the excess of carbonic acid is driven off and the lime is rendered insoluble, whereas the sulphate of lime only precipitates at higher temperatures, and forms what is known as permanent hardness to distinguish it from the temporary hardness, which is removed by boiling, as above. Clark's principle of treatment consisted of adding slaked lime (hydrate of calcium) to the hard water in just sufficient quantity to remove the excess of carbonic acid which rendered the lime carbonate soluble. The removal of the gas thus caused the carbonate to precipitate, and the added lime also precipitated, being converted to carbonate itself by the absorbed carbonic acid; thus

$$Ca\,CO_3 + CO_2 + Ca\,OH_2O = 2\,Ca\,CO_3 + H_2O;$$

a proportion of water being set free from the slaked lime.

With sulphate of lime the addition of soda is necessary, thus

$$Ca\,SO_4 + Na_2\,CO_3 = Ca\,CO_3 + Na_2\,SO_4;$$

the result being carbonate of lime as before, and sulphate of soda—a very soluble salt, only to be got rid of ultimately by blowing out. Sulphate and carbonate of magnesia ($Mg\,CO_3$ and $Mg\,SO_4$) are dealt with exactly as their corresponding lime salts with the formation of lime carbonate and sodium sulphate respectively, and in each case of $Mg\,OH_2O$, or hydrate of magnesia. Where both carbonate and sulphate of lime is present, it was shown many years ago by the late Dr. Angus Smith, in a report to the Manchester Steam Users Association, that the treatment should embody the addition of caustic soda in place of sodium carbonate. The caustic soda took up the carbonic acid from the lime carbonate, and becoming carbonate of soda, then attacked the sulphate of lime. The amount of caustic soda to be added was thus just sufficient to produce the carbonate necessary to convert the lime sulphate. The proportions, of course, depend upon the relative proportions of the lime salts in the water. When lime carbonate is thus separated out from water, it is in microscopical particles, and does not readily precipitate. These particles aggregate and become heavier; they then sink, and the water clears. It was found that if some old precipitate was stirred up with the newly treated water, the old particles formed nuclei, round which the new deposit could crystallise, and this fact is made use of in the Archbutt and Deeley system. They use a couple of tanks in their system. Ultimately they are filled with the water to be treated, the lime water is run in in sufficient quantity; also any soda that may be required, and sometimes a little sulphate of alumina. These are blown in with steam and thoroughly mixed. A test is next made with nitrate of silver—an excess of lime producing a brown colour, the proper proportion a faint straw tint.

The mixture is now ready for settlement, and to facilitate this, air is forcibly injected by perforated pipes laid in the bottom of the tank. This stirs up the old deposit, of which a quantity is always allowed to remain, and then the tank is left to subside. The top water quickly clears, and is drawn off by a floating outlet pipe, and as the water is drawn off always from the surface, the fullest clarification is permitted in the lower part of the tank. Water containing organic matter like that of a river, or with sewage pollution like that supplied by the London water companies, does not clear so rapidly as spring water, hence the addition of the alumina to serve as a coagulating agent, and so hasten the precipitation. Probably the magnesia is deposited like the lime, but to some extent it is also converted, as shown, into hydrate, which is apt to deposit in injectors and valves, and to clog them. To prevent this, Messrs. Archbutt and Deeley recarbonate the water after treatment, and reconvert this magnesium hydrate into carbonate, which will now pass forward to the boiler without depositing on the way. The carbonic acid gas is made in a small coke stove and blown into the water by steam.

The following is an analysis of the water used by the Midland Railway at Derby:—

	Grains per gallon.
Carbonate of lime	9·74
Sulphate of lime	5·64
Sulphate of magnesia	1·35
Carbonate of magnesia	2·45
Sulphate of soda	3·41
Chloride of soda	2·81
Silica	0·34
	25·74

Calculated hardness, 17·9°.

After treatment, the following analysis is given:—

	Grains per gallon.
Carbonate of lime	2·25
Carbonate of magnesia...	2·18
Carbonate of soda	0·85
Sulphate of soda...	11·33
Chloride of soda	3·38
Silica	0·48
	20·47

Calculated hardness, 4·8°.

The increase of silica and sodium chloride is due to impurity in the ingredients employed, and comes in probably with the soda ash.

The sulphate of soda is increased by the equivalent of sulphate of lime removed. The total solid matter is not therefore much reduced in weight, but it is changed in nature; is more soluble and less destructive of soap. The water is therefore softened. Purer soda would thus give better results. The advantages claimed for the Archbutt and Deeley processes, or rather the apparatus, is the stirring by air of the treated water with the old deposit to facilitate settlement and the recarbonating of the magnesium hydrate, to prevent clogging of the valves and injectors. Trade refuse is also treated by the system, and, of course, every water requires its own particular treatment as regards the ingredients to be employed, dye stuff in trade refuse being a difficult thing to remove, because it must be taken up by solid matter, and precipitated in that way. One of the worst impurities found in water is magnesium chloride. It is of special danger where high pressure steam is used, because it is an unstable salt, and decomposes to magnesia and hydrochloric acid. Steam users who are troubled with this salt may improve matters by adding common salt, the effect of which appears to be to add to the stability of the magnesium chloride, possibly, by giving greater chemical equilibrium to the general mass, as to which there is much room for study, the action of feed waters being, we think, considerably different since the introduction of higher pressures. There are some waters that are amenable to no kind of treatment. Such are the waters containing lime sulphate, and a full dose of soluble salts that cannot be changed. The lime sulphate only adds its further quota to the already existing soluble matter, and there is a danger of supersaturation occurring in a steam boiler, if blowing-out is not attended to. For most waters, however, the devices of Archbutt and Deeley are well calculated to carry out the continual softening of water for large users, and, at the same time, the recarbonation process will get the softened water through the fittings, where it is apt to cause trouble.

THE EFFICIENCY OF WORM GEARING.

We referred in a recent number to the use of worm gears for electric motor gearing, and we instanced the worm gearing of the Wilkinson tramway engine as an example of a gear which was at least so good that, when running down hill without steam, the engines which carried the worm upon their crank shaft were made to revolve through the driving of the worm by the wheel. We thought that this was a proof that there might be a worm gear that had an efficiency of more than 50 per cent., and that, given good design and lubrication, a worm gear might be run without excessive wear.

This subject has since been referred to in the *Mechanical World*, and a worm gear made at Oerlikon works is described, having a worm of $3\frac{1}{8}$ inch diameter, engaging a bronze wheel of 28 teeth and $14\frac{3}{4}$ inches diameter, the whole running in an oil box, and at 1,500 revolutions per minute, giving 21 B.H.P., with an efficiency of 87 per cent. (we believe 78 is intended). The worm is double-threaded. Mr. E. Kolben, of the Oerlikon works, believes that over 80 per cent. efficiency could be obtained under suitable conditions of speed and design, and he advocates a starting speed of 20 to 40 feet per second and worms of large diameter. The worms should be turned out of solid steel, tempered and polished and run in a bath of oil, when, with bronze wheel, the frictional coefficient may be as low as 0·01 or 0·005, and such gear will wear for years. This type of gear would certainly, if thus satisfactory, make an admirable gear for motor cars, the speed being at once reduced 10 to 20 times from the motor.

The design of a worm gear is far from easy. It is common to hear it said that a worm is simply a form of rack with teeth of curved outline, and that the worm wheel needs only be formed on this supposition; but such is not the case by any means. The longitudinal section of a worm would show the form of the tooth or thread where it gears with the middle of the breadth of the wheel, but this section—taken upon a radius or diametral line—is not the thread section at any other part of the wheel breadth. To show the form other than at the middle breadth of the wheel, other sections of the worm need to be taken parallel to the diametral section, and it would then be perceived how the threads, as seen in section, varied from the diametral section. Now, it is this curiously-shaped rack tooth which advances upon the teeth of the worm wheel, and it is obvious, therefore, that the teeth of the latter must vary over their whole breadth, if they are to gear properly with the worm. Hence the desirableness of making worms of as large a diameter as possible, in order that the breadth of the wheel necessary for strength shall subtend as small a portion of the worm as possible. Properly speaking, without an infinity of care, it would be difficult to find the exact tooth for the wheel. The tooth form might be found at three or four points in the breadth of the wheel, and the rest of the tooth carved to a surface passing through these points; but the better plan is to cut a worm into a milling tool, and mill out a worm wheel pattern from which to cast. Such a pattern needs to be in halves, being divided at the middle breadth of the teeth into two wheels by a circumferential division. A worm wheel thus cast cannot fail to be as correct as possible. In using such a worm as above described as a milling tool, the worm and wheel should be revolved together by means of another worm and a wheel of very narrow face, so as to preserve the correct relative positions of the worm—or, as it would now be termed, the hob—and the wheel. The finished wheel is, of course, hollow on the face, fitting the curvature of the worm, and the outer ends of the wheel teeth will be found of very different form from the centre portion, which, as stated, may be simply designed as an ordinary rack wheel. The importance of having the worm large in relation to the breadth of the wheel becomes apparent, but there is, of course, a limit to worm diameter. This limit is dependent upon the speed of revolution, too great a worm diameter implying a high velocity of rubbing contact with the wheel. Wilkinson's worms were large. We have not the figures by us, but they were probably 7 inches gross diameter, and the teeth of the wheel did not thus depart far from the form they would have if driven by a rack. It is necessary to remember, that for each tooth moved by the worm wheel, the worm, when single threaded, must move a whole circumference in pressure contact with the wheel, and that even with a small coefficient of friction the product of the pressure, which in a tramcar will be greater than the tractive force, and the worm velocity may, with the coefficient, be quite a large figure. Thus with a coefficient of 0·01, and a worm wheel of half the diameter of the driving wheels, each pound of tractive force, where the speed ratio is reduced 20 times in the gear, represents $\pi \times 2 \times 20 \times d \times 0{\cdot}01$, or nearly $13\,d$ pounds per revolution of the driving wheels, d being the diameter of the worm. Thus, if the car advances 9 feet per revolution, and energy has been expended of 9 foot-pounds, a worm of one-half a foot in diameter will swallow $6\frac{1}{2}$ foot-pounds, the efficiency being thus only a little over $\frac{2}{3}$ths; actually 0·58. With the possible coefficient of 0·005, the efficiency would be 0·73. Hence the need of the bath of oil to wash all gritty particles off the rubbing surfaces, without which abrasion is apt to be set up.

ENERGY LOSSES IN DIELECTRICS.

It is well known that when condensers are placed in circuits with rapidly alternating currents, a considerable amount of heat is developed in the dielectric. Many investigators have worked at this interesting subject, since the experiments of Siemens, first in 1891, brought it into notice. The latest experiments by Eisler, described in the *Zeitschrift für Elektrotechnik*, June 15th last, have determined how this loss varies with the capacity of the condenser, the tension, and the frequency of the alternating charging current, and go far to decide to what properties of the dielectric the loss is due.

From an excellent account by Gasnier,* of the work of previous investigators on the loss of energy in dielectrics, we learn that Steinmetz first measured these losses of energy in a paraffined paper condenser of 5 microfarads capacity with an alternating current having a frequency of 170. He found that the loss was about 12 times as much as that created by a continuous current; he also found that this loss increased in proportion to the square of the tension. Steinmetz considered this loss was due to some property of the dielectric analogous to that which, in the magnetic metals produces hysteresis. This explanation has not received much support from subsequent investigations; Eisler, in fact, in his latest experiments, referred to above, considers that he has shown that dielectric hysteresis, in the strict sense of the term, has no existence.

M. Arno † constructed an apparatus which showed that a rotating electrostatic field exercised a turning effect on a dielectric cylinder suspended in it. This experiment being exactly analogous to an experiment made by Ferrari with the rotating magnetic field, Arno concluded that it was due to an effect in the dielectric analogous to magnetic hysteresis. This effect, however, is capable of a different explanation.

The experiments of Bour and Rayleigh to determine the value of permeability as a function of the induction, showed that iron exhibits a retardation of magnetisation which is not due to hysteresis proper, and which prevents the magnetic condition from following rapid variations of the magnetising field; this phenomenon occurs especially with feeble magnetising forces, for which the permeability of the iron is constant. Ewing has named this effect viscous hysteresis, and it gives rise to a loss of energy in a cyclically varying field which increases with the frequency. The loss from hysteresis proper is independent of the frequency, and in this circumstance we have a means of distinguishing between these two kinds of loss. Another peculiarity of viscous hysteresis is, that the final value of the induction diminishes when the frequency of the cyclic variation of the field increases. To decide, therefore, whether the loss of energy in dielectrics is analogous to ordinary magnetic hysteresis or to viscous hysteresis, we can apply the above two tests. The experiments of Northrup ‡ showed that dielectrics in a cyclically varying electrostatic field exhibit both the characteristics of viscous hysteresis. The value of the specific inductive capacity was greater for a slowly varying field than for a rapidly varying field.

The Arno effect may therefore be due to something taking place in the dielectric analogous to viscous hysteresis.

Hess § attributes these losses to the heterogeneity of dielectrics, *i.e.*, to the existence in them of conducting particles through which veritable currents circulate. M. Hess compares a condenser, having a heterogeneous dielectric, to two condensers mounted in series, one having an infinite resistance, and the other the resistance of insulation. Calculation shows that such a condenser will retain residual charges, and is, in fact, equivalent to a condenser with viscosity. Carpentier has verified these predictions by experiment.

M. Charles Borel has arrived at similar conclusions to Hess, and attributes the Arno effect to this internal conduction.

Porter ‖ and Morris, from experiments on a paraffined paper condenser, came to the conclusion that no such thing as dielectric hysteresis proper existed, and that the energy losses in dielectrics were entirely due to viscosity.

Eisler's recent measurements were directed to the determination of this same problem, whether the increased loss of energy in dielectrics with alternating currents was due to a cause analagous to magnetic hysteresis. He adopts Maxwell's theory of the condenser, namely, that it can be represented by a high resistance in shunt with a condenser which is a perfect insulator. If an alternating E.M.F. is impressed upon such a system, an alternating current will be produced in the resistance branch of the shunt, which is in phase with the impressed E.M.F., while in the condenser branch the current produced will be $\frac{1}{4}$ period in advance of the impressed E.M.F. The loss of energy in this case is entirely in the resistance branch of the shunt, and is equal to $\frac{E^2}{R} = E\,C_2$, where C_2 is the current in the resistance shunt. If, from any cause, there is also a loss of energy in the condenser, the current, C_1, in the condenser branch will no longer be 90° in advance of C_2, but something less, and the current, C^1_2, to be multiplied by the E.M.F. to obtain the watts consumed will be greater.

If A is the total watts supplied, W, the watts lost in the condenser, and $\frac{E^2}{R}$ that lost in the resistance shunt, then $W = A - \frac{E^2}{R}$. In each of Eisler's experiments three quantities were measured, the effective tension at the terminals of the condenser, the intensity of the current in the main circuit, and the power absorbed.

The difference of potential (34·9 volts) was maintained constant at the terminals of the condenser. The frequency was varied from 17·9 to 45·1 periods per second. The results of Eisler's experiments are summarised in the following table:—

Frequency periods per second.	Current in main circuit. Ampères.	Apparent resistance of condenser in ohms.	Loss of energy in ergs. per cycle.	Angle of lead.
17·9	·0084	64,800	10,490	86°·21
29·3	·0137	35,100	11,670	85°·50
33·9	·0153	31,500	11,420	85°·56
41·7	·0186	24,900	11,790	85°·41
45·1	·0198	22,100	12,250	85°·28

The apparent resistance in the third column is that resistance which would produce the same loss as takes place in the condenser. It will be seen from the fourth column that the loss in ergs. per cycle increases with the frequency. This would not take place if the loss was due to hysteresis proper. Eisler thinks that this loss, which he attributes to viscosity, ought to show a maximum for higher frequencies than he has been able to employ in his experiments.

Eisler has also made measurements with constant frequency and varying potential difference. His results confirm those of Steinmetz, viz., that the loss of energy is proportional to the square of the difference of potential.

Eisler gives the following general expression for dielectric hysteresis:—

$$L = k_2\, C_n \ldots f(n)\, E^2$$

in which formula, L, is the work absorbed, per cycle for the whole volume of the condenser, k_2 a constant depending only on the material of the dielectric, C_n the capacity with the frequency n, E the effective E.M.F. The form of the function $f_n(n)$ is not known, only we know that for a certain value of n, $C_n f(n)$ will be a maximum. This equation means that.

1. If condensers of different capacity, with similar dielectrics, are subjected to the same alternating E.M.F. and frequency, the work absorbed per period is proportional to the capacity.

2. One and the same condenser subjected to different E.M.Fs. of the same frequency, absorbs an amount of work per period proportional to the square of the E.M.F.

3. One and the same condenser subjected to the same E.M.F. at different frequencies, absorbs per period an amount of work depending on the frequency; at first it increases with the frequency, reaches a maximum, then decreases.

* *L'Industrie Electrique*, p. 425.
† *Electrical Review*, London, Vol. 32, p. 79.
‡ *Phil. Mag.*, 1887.
§ *Journal de Physique*, April, 1893.
‖ *Electrician*, April 12th, 1895.

CONTINUOUS RAILS.

The continuous rail and the methods of making it are reviewed by Mr. R. M'Culloch in a paper recently read before the Engineers' Club, of St. Louis. The continuous rail seems to have fairly taken hold in America, and there is no question but that it will have a good trial, seeing how the life of a rail is really only that of the joint which gives out long before the rail itself is worn out in other respects. The success of the continuous rail obviously depends upon first whether a rail so connected can be relied on not to break under the tension produced by a lowering of temperature below that at which the rails were welded, and secondly, that they shall be laterally supported so as not to be displaced by the crushing stress when they rise above the temperature at which they were welded. These figures of stress can be calculated.

Steel has a coefficient of extension of expansion of 0·0000065, and the range of total temperature will not exceed 150° F. In England, we might very well take it as 60°, and even that would be exceptional. One half the range is 75°, and the fraction of length difference is 0·0004875. Now, a steel bar will expand 0·00003 of its length for each 1,000 lbs. of tensile stress. The temperature stress is thus seen to be 16,200 lbs. per square inch of section, or 137,700 lbs, on the rail of 8½ inches cross-section. The elastic limit of steel is safely put at 40,000 lbs., so that this huge temperature range of 75° on each side of a mean temperature at which welding is done shows a marginal factor of five, and even of 10 on the ultimate strength of 80,000 lbs. It is, of course, the firm grip of the rails by the earth and road bed in which they are closely packed, that prevents the rails moving locally to any great extent. For example, a fall of 75° would probably cause a contraction of 8 feet 6 inches in the continuous rail of the Baden division of the St. Louis tramways, each rail being 3¼ miles in length; yet when some joints broke no gap exceeded 2 inches, and the total gap did not exceed 6 inches, showing that in the course of the 3¼ miles, the stress due to the other 8 feet of potential contraction must have been taken by the road bed grip upon the rail.

The first continuous rail was that of 3 miles of track in Virginia, laid close butted and riveted up with hot fish plates. It was several years in use on an ordinary railroad. Then in 1892, the Johnson Company close jointed a length of 1,160 feet with heavy bars and turned bolts, and drove wedges into the spaces, and no movement could be detected any way with a range of 79° F. This company then began rail welding with a machine built by the Thomson Welding Company, and in 1893 welded up 3 miles in Johnstown, and 8 miles in Boston, and next year did 6½ miles in St. Louis, 5 miles in Cleveland, and 32 miles of track in Brooklyn.

The earlier welding was done by welding a piece to each rail web, 4 inches from the rail end; but this proved unsatisfactory, and the butt weld was then made. The alternating current is taken by four leads from the windings of a 100-kw. general electric four-pole dynamo, at equal distances round the armature, and they are led to two collector rings on the armature shaft. As the speed is 1,100, the periodicity is 4,400 per minute, and the original current is 500 volts and 250 ampères. It is transformed down to 4 volts, and thus 20,000 to 30,000 ampères pass through the rail lugs. These lugs are four in number, and are welded two at a time to the rail web, being pressed against this on each side sufficiently to force sufficient plastic steel between the rail ends to form the joint to make a butt weld, the lugs themselves being an additional security. The rails are actually butted as closely as possible by driving a wedge in the next joint ahead, and the rail ends are cleaned by emery wheels, every operation being carried on from the welding car of 30 tons weight, which is run over the joint before the weld is made, so that it does not run over a hot new joint. The top of the rail is kept covered by a piece of carbon, which keeps it smooth, and also hardens the rail. In St. Louis, the machine completed 30 to 50 joints per day. Two cars are now used in the newer plant, the rotary transformer and the welding machine being in separate cars connected by a cable, and in place of a toggle joint device to force the welding lugs against the rail, a hydraulic jack is now employed.

The success of welding brought into existence the method of cast welding already referred to in our columns, and consisting in the running of a casting about 16 inches long upon each joint, the metal being run hot, and if properly done the union of the metal and rail is perfect.

The portable cupola in which the metal is melted is bricklined, and 2 feet in diameter, driven by a Sturtevant fan and 5 H.P. motor. Half scrap and half soft grey pig is used, and pouring may be commenced in 20 minutes after blast is turned on. As many as 72 joints have been poured at one melting. The operation consists in removing fish plates, cleaning the ends of each rail for a length of 8 inches, closing any gap by a shim, laying on the moulds, which are cast-iron, and clamping firmly and pouring the metal, a joint taking about 137 lbs. of iron, and when finished being 14 inches long and embracing two bolt holes in each rail end.

Of 2,203 joints electrically welded on the Baden line, 37 broke in the early winter, and were repaired by cast welding, and 35 broke during the later cold weather and have not yet been repaired. The temperature when the electric welding was done was a mean of 63°, varying from 14° to 99°. The winter temperature fell to — 12°, and the summer temperature got up to 100°.

[This is quite the ordinary thing in America, where the climate is supposed so superior to the English climate.]

All the joints which broke showed defective welds; seven of them opened 2 inches, but the average was only ¼ inch, and the experience is not by any means discouraging, so that with more experience an insignificant breakage percentage is anticipated in future work. Thus in place of the 3·27 per cent. of breakage which these figures show, the percentage in Cleveland was only 0·18 in 3,400 joints made in the summer of 1894, six joints only giving way and showing defective welding.

Of 744 joints cast-welded on the South-Western Railway on Chippewa Street, between 18° and 84° F., only 0·43 per cent. have broken, though the temperature has since ranged from — 12° to 100°.

Comparing the two methods, the electric weld is described as beautifully scientific, but of too exacting a nature as to the qualifications it demands in workmen, whereas numerous men can be had who are familiar with the operations involved in the cast welding process. The electric plant is costly; it is also very heavy, and not easily transportable for use on many lines, besides being out of the way when needed for repairs, and the cast welding process is rather held up in preference to it, despite the fact that the joint is, after all, only a casting with the attendant possibilities of chill, blowholes, and differential stresses from the steel rail. Neither method is much more costly than the fish plate joint, and when it is considered how the rail life is prolonged by abolishing end battering, and how the repairs to the rolling stock must also be diminished, not to name the comfort of passengers, the processes of welding must surely be taken up, and if they can be so much of a success in the wide range of temperature in America, they cannot fail to be almost faultless in our own better and more equable climate.

A SUGGESTION FOR A DAY LOAD IN ALTERNATING CURRENT LIGHTING STATIONS.

There are many existing lighting stations of to-day where the lighting load is met by two or three simple alternators. Very often it is the case that they are identical in speed, and they are always identical in frequency. Occasionally, says the *Electrical World*, they are driven from two fly-wheels of the same high-speed engine. Lighting stations which are so fortunate as to possess such an arrangement have at their command a method of carrying a power load at a very slight expense. By rigidly coupling the two shafts of two similar alternators together so that their armatures bear the proper relation to each other, two-phase currents—that is, two currents, of which one has its maximum value when the other is at zero—may be obtained for the operation of two-phased motors, which type of motor, unlike the simple, alternating

type, can be started with or without load in the same manner as a continuous current motor.

The mutual working of these currents can be more accurately regulated than can the currents of a regular two-phased machine. In the case of a two-phased machine, should one of the circuits have a heavier load than the other, it will require a stronger field to maintain its voltage, which will cause the coils of the other circuit to deliver a voltage that is too high. In the case of two single-phased machines connected in this manner, the difficulty is in no wise present, as each machine will operate with its load precisely as if the other machine did not exist. No line wires installed need be taken down, or any change made in the type of transformers. Wherever a motor is to be operated it is only necessary to bring to the place lines from both alternators and connect with two transformers. The motor will operate at an efficiency equal to, if not superior to, the best direct-circuit motor, and require considerably less attention. Power is now frequently transmitted for city purposes at 500 volts, but the saving in copper in transmitting at 1,100 or 2,200 volts, as the case may be, is very considerable, being inversely as the square of the voltage. It is quite probable that the manufacturers will frown upon this method, and some, perhaps, go so far as to say that such operation is impossible, but, nevertheless, those who care to try it will find it entirely practicable. It is surprising to the writer that it has not been frequently practised heretofore. Stations using alternating current generators, and proposing to increase their system, will do well to consider duplicating the single-phase alternator they already possess, as by this means the plant capacity will be increased, the amount of that unit *for both light and power*, and the installation of the combination indicated, may even be worthy of consideration in new stations. Its merit lies in the fact that absolutely no material is relegated to the scrap heap by its introduction. It may be added, that once having two-phased currents, three-phased currents can be very economically produced by means of special transformers.

CORRESPONDENCE.

The Institution of Electrical Engineers.

Some years ago I found myself in identically the same position as Mr. Raworth was at the last annual meeting, and although the proposals I wished to make were, I think, calculated to enhance the usefulness of the Institute, I refrained from getting 10 members to ask for an extraordinary meeting. Put it as we will, an extraordinary meeting convened at the request of members has an appearance of hostility to the Council body, which none of us want. I venture, however, to express the hope that the Council will themselves appoint a committee for the purpose of considering whether a revision of the rules has not, by reason of the vast increase of members, become advisable. If the committee arrived at the conclusion that the rules may be improved upon, the proposed revision could be circulated amongst the members, and the Council themselves might call an extraordinary meeting.

Having said so much, perhaps one ought to suggest one or two points that seem worthy of consideration.

Do we not use up our presidents too quickly? Why should they not keep office for two years?

As to qualification, the second rule is, to say the least, vague. Is it not an anomaly that the senior vice-president should be entitled, in the absence of the president, to preside at a Council meeting, and yet may by some not be considered eligible for the office of President? and last, though not least, surely in a large Institution, such as ours has become, there ought to be some legitimate and recognised method by which members may, at the annual meeting, bring forward proposals for the benefit of the Institution, without being placed in the invidious position of being obliged to move an amendment on the report of the Council.

S. Flood-Page.

The Livet Destructor.

In your issue of to-day, you comment upon the Livet boiler.

It may be interesting to your readers to know that this Vestry laid down a Livet boiler 18 months ago, which burns nothing but house dust as it is collected.

Among other things, we run a dynamo for 84 16-C.P. incandescent and two 500-C.P. arc lamps, a saw, mortar mill, and chaff-cutter.

G. R. W. Wheeler,
Surveyor, St. Margaret and St. John, Westminster.

December 20th, 1895.

I beg to point out the misstatement in your article of 20th inst. to the effect that I was to receive £470,000 in fully paid up shares of the Refuse Utilisation Company, together with £30,000 in cash.

These amounts were to be shared between the three promoters and myself, my share being £220,000 in fully paid up shares and £6,000 cash. As a matter of fact I have received, in all, £286.

I shall thank you to insert this letter in your next issue, and oblige.

Georgina F. de Livet.

Chelsea, *December 23rd*, 1895.

Review.

Dans la bibliographie contenue dans l' Electrical Review du 13 courant, il y a au sujet des *Mesures Electriques* que j'ai publies des inexactitudes que se leurs à relever.

Vous trouvez incorrect de dire que dans le cas d'un galvanomètre dont l'échelle est un arc de circonference d'un rayon égal à sa distance au miroir, le courant est proportionnel non pas à la tangente de la demi-deviation, mais à la demi-deviation. L'exactitude de cet fait est cependant evidente.

Vous niez également la condition théorique de l'égalité des branches du Pont de Wheatstone en vue de l'obtention du maximum de sensibilité. C'est cependant le condition recherchée dans la comparaison des étalons.

Je souhaite que votre critique peu bienveillante porte autant de bonheur à sur *Mesures Electriques* que cella non moins acerbe qui vous avez adressée naquire à sur *Lecons sur l'Electricité*, qui ont en quatre édition en quartre ans.

Eric Gerard.
Directeur de l'Institut Electrotechnique, Montefiore.

[We regret that we misunderstood M. Gerard's contention to be that the *currents* would be proportional to the semi-deviations on a circular scale, whereas, he states (what is, of course, obvious) that the *angular deflections* are proportional to the semi-deviations.—Eds. Elec. Rev.]

THE GENERAL THERAPEUTIC EFFECT OF THE ALTERNATING ELECTRIC CURRENT OF HIGH FREQUENCY AND OF HIGH TENSION.*

Dr. G. Apostoli (Paris), together with Dr. Berlioz, on March 18th, 1895, presented a paper on the above-mentioned subject to the Academy of Sciences of Paris. He now, after longer and riper experience, desires to present a summary statement of his general conclusions: 1. According to Professor d'Arsonval's discoveries alternating currents of high frequency and of high tension exert a powerful action upon all living bodies submitted to their inductive influence. 2. The best methods of applying these induced currents is to place the patient, free from all contact with electrodes, in the circuit of a large solenoide traversed by the currents. The patient being thus completely insulated, the currents, which circulate in his body by auto conduction, have their origin in his tissues. The body plays the *rôle* of a closed induced circuit. 3. By this method the physiological discoveries of Professor d'Arsonval are confirmed and we are able to prove the powerful influence of these currents upon the vasomotor system, although they produce absolutely no sensation, and

* The *British Medical Journal*.

although they have no apparent effect upon the motor or sensory nerves. These currents have nevertheless a powerful action upon all the nutritive functions, as has been verified by Dr. d'Arsonval's numerous analyses of the gaseous products of respiration, and by Dr. Berlioz's not less numerous analyses of the urinary excreta. 4. The general therapeutic applications to be deduced from this physiological action are confirmed by clinical observation. Dr. Apostoli has now treated more than a hundred patients by this method at his clinic and at his private consultation rooms. The greater number of these patients have been greatly benefited by this new treatment, which, be it remarked, has been used to the exclusion of all other forms of medication, dietetic or otherwise. 5. These currents exert in the majority of cases a most powerful and generally beneficial action upon diseases due to slackening of the nutrition by accelerating organic exchanges and combustion. This is proved by analyses of the urine made by Dr. Berlioz, of which the following is a brief summary: The quantity becomes more normal; the products of organic waste are better eliminated. The increased combustion is shown by the diminution of uric acid, while the percentage of urea is generally increased. The relative proportion of these two substances changes under treatment so as to reach in general the figure of 1(:)40. The elimination of the mineral products is also affected, but to a less marked extent. 6. When daily *séances* are given, each lasting 15 minutes, we may generally observe in patients submitted to the influence of these currents the following modifications in their general condition. We mention them in the order of their occurrence:—Return of sleep; increase of strength and vital energy; increase of gaiety, of power for work, and ability to walk; improvement of appetite, &c.; in short, general progressive improvement. This general improvement often manifests itself after the first *séances*, before any local influence is apparent, and before any change has occurred in the urinary secretions. 7. Local pain and trophic changes are often more slowly affected by these currents, and at times they are entirely refracted for a longer or shorter period. In such cases the same currents must be applied locally by contact with the electrodes. This subject will be treated later on in a separate communication. 8. The diseases which have appeared incurable by this treatment are those not associated with well-defined organic changes, such as hysteria and certain forms of neurasthenia. Dr. Apostoli has also observed that certain localised neuralgias are refractory to this form of currents; they require its more direct local application. 9. The diseases which have derived most benefit from this therapeutic agent belong to the arthritic class, rheumatism and gout. 10. In certain diabetic subjects the sugar has disappeared altogether from the urine under the influence of these currents, while in others there has been no such change, notwithstanding the manifest and constant improvement in the general condition. Is this difference due to the imperfection of the electric apparatus or to the manner of its application? It is hoped that further experience will soon afford an answer to this question, although the fact that diabetes has many different causes may in itself explain the difference in the results obtained by this treatment. 11. In conclusion, the currents of high frequency and of high tension introduced into electro-therapeutics by Dr. d'Arsonval greatly increase the field of action of medical electricity. They furnish general medicine with a new and valuable means of treatment, capable of modifying more or less profoundly the processes of nutrition.

BUSINESS NOTICES, &c.

Annual Dinner.—On Saturday evening the eighth annual dinner of the workmen of Messrs. J. H. Holmes & Co., electrical engineers, was held at the Crown Hotel, Clayton Street, Newcastle.

Appointments.—Messrs. P. R. Jackson & Co., Limited, of Manchester, have just made the following additions to their staff:—Mr. W. H. Ravenshaw, A.M.Inst.C.E. (of Booth & Ravenshaw, 110, Cannon Street, E.C.), as consulting electrical engineer; Mr. E. J. Blandy, A.M.Inst.C.E., as representative in South Wales and the Midland Counties; Mr. A. M. Shepherd, of 32, Albany Road, Ealing, W., as representative in London and the Southern Counties; Mr. W. F. Jones (late of Easton, Anderson & Goolden), as assistant engineer; and Mr. Felix J. Howitt (late of the Norwich Electricity Supply Company), as assistant electrical engineer.

Books Received.—"Dynamo Electric Machinery," by Prof. S. P. Thompson. Fifth edition, revised. Messrs. E. & F. N. Spon. Price 24s.

Catalogues, Price Lists, &c.—From Messrs. Hayward Tyler & Co. we have received a copy of their new catalogue (list C, 1895), of pumping machinery. There is a variety of ordinary lift and force pumps, syphon, ornamental, boiler feed and proving pumps, California and other fire engines, well engines and pumps, plunger, air and gas condensing, and chain pumps, horse gears and deep well pumps, duplex steam pumps and hot air engines, also a great number of pumping apparatus, fittings and accessories. Several pages are devoted to electrically driven pumps of the trunk plunger pattern, the sizes, prices, and capacities of the pumps and motors being given along with illustrations. The catalogue, which contains over 300 pages, is profusely illustrated and nicely bound in red covers.

We have before us a copy of the new edition (1896) of Messrs. Clarke, Chapman & Co.'s electrical catalogue. The book contains only such machinery and appliances as are entirely manufactured in the electrical department of the company's works. It commences with several full-page and excellently executed photographic illustrations of the various sections of the electrical shops. These are followed by illustrated descriptions of their high-speed vertical steam engines specially designed for electrical work, combined engines and dynamos as used for ship lighting, belt driven dynamos of various types and voltages, projectors of the Admiralty and other types, lamps, mirrors, switches, and similar accessories, electric galvanising plant, portable dip pump, and other things. A full-page photograph shows a portable electric generator and search light plant, supplied for river navigation in India, while several pages are devoted to electric travelling cranes. The work of illustration has been carried out with great pains, and everything has been most neatly and pleasingly arranged. We have pleasure in recommending the catalogue as an excellent piece of printing work, as well as an interesting production from an electrical point of view.

Messrs. Sharp & Kent have sent us one of their new lists relating to concentric wiring, which comes at an opportune moment in view of the attention at present being given to the subject. The list includes a complete system of switches, fuses, sockets, and lamps for use with earthed conductors. We understand this firm has had considerable experience in this method of wiring, having installed something like 5,000 lights during the past 12 months on the system. Messrs. Sharp & Kent have also sent us a pamphlet of testimonials received in favour of the Weymersch electric battery, of which they are the sole manufacturers. Other lists from the same firm deal with the "Standard" telephone, the "Star" carbons, bells, batteries, and accessories.

The British Aluminium Company are wishing their friends the compliments of the season by means of a fancy aluminium wafer, which is very tastefully illustrated on the front with a pretty little sketch of St. Paul's Cathedral, while on the back is a calendar for 1896, and other useful information given in a very small compass.

Messrs. Dorman, Long & Co., of Middlesborough, have just issued a "Handbook of Steel Sections." There is a host of tabulated and other detail which will be of service to customers and all users of steel work.

The Direct United States Cable Company, Limited, has sent us as usual, a date calendar with a slip for each day in the year 1896.

Messrs. Cutting Brothers of Derby have brought out a new list of their continuous current dynamos and motors.

Two lists of engines and dynamos have been sent to us by Messrs. W. H. Allen & Co.

Leather Belting.—We have received from Messrs. J. W. Cable and Co., of Clerkenwell Road, London, a copy of the Engineer's guide to the width of leather belt required to transmit any given horse power. The card gives the information in tabulated form, the compiler being Mr. J. W. Cable. He states that "Experience has shown that there are many engineers and mechanics to whom a guide of this kind would be welcome, particularly as the results are obtained without any intricate calculations, a simple multiplication sum being all that is necessary."

Notice.—Mr. G. A. Nussbaum requests us to state that the English patent for the Berthon transmitter is still in full force, and consequently persons dealing in that article—and he says infringers are numerous—not made by La Société Industrielle des Téléphones will be liable to legal proceedings.

People's Palace Exhibition, 1896.—A prospectus and schedule of prizes have been published by the honorary secretaries of the East London Trades, Industries and Arts Exhibition and general exhibition of the work of students in polytechnics and technical institutes, to be held at the People's Palace in June, 1896. Section 1, Group VI., is devoted to exhibits in the engineering and metal trades, and among the various items we observe electric appliances, steam, gas and oil engines. In Section 3, which is to be devoted to exhibits by individual students and apprentices, Division XII. offers small prizes for electrical appliances, a special one being offered for "joining conductors." The exhibition is receiving splendid support from a number of influential vice-presidents and executive and general committees and there is little doubt that it will be successful, particularly in the direction of encouraging industry in the East end of London.

Presentation.—Mr. Henry Gardner, patent agent, of 166, Fleet Street, London, was, on Friday last, 20th inst., presented by his staff with a magnificent large portrait of himself, handsomely framed, in commemoration of his 65th birthday, and on his election as president of the Society of Patent Agents.

Trade Marks.—Messrs. W. P. Thompson & Co., patent agents, write us as follows:—"An important decision has just been made by the Patent Office as regards signatures as trade marks. Section 64, sub-section A, of the Patent Act of 1888, states 'that a trade mark can consist of a name of an individual or firm, printed, impressed, or woven in some particular or distinctive manner.' The Patent Office, with the approval of Sir Richard Webster, the Attorney General, has now decided that such a signature as 'The London Stout Company' or the 'Eagle Brand Company,' or, we presume, the 'Midland Railway Company,' even though it be the real trading name of the company, cannot be registered as a trade mark, and that no signatures will be allowed unless they consist of a personal name or personal names, with or without we presume the addition of '& Co.,' '& Son,' or the like. Furthermore, the Office have already decided that no trade mark having no other distinctive part than a personal name, such as in the case of 'Wilkinsop's Liver Pills,' or consisting of a single word such as 'Lamb,' 'House,' or 'Chestnut,' and which is found in a directory as a surname, can be registered, and Judge North has gone so far as to extend this decision to any personal name found in any novel or other book, and in particular has refused to recognise as a trade mark the name 'Trilby,' on the ground that it is a personal name in a novel, though there is no proof that it has ever been an actual surname."

The Year's Work.—Messrs. J. H. Heathman & Co. report that during 1895 they have been busily engaged with orders for their patent telescopic ladders, trestles, steps, towers and scaffolds for service in connection with electric light installations, and improvements have been effected with a view to the saving of labour in recarboning arc lamps, and the clearing and replacement of incandescents.

Wood Casings.—Messrs. Thomas Adams & Sons, of Birmingham, have sent us a sheet showing illustrations of their wood casings for electric light wiring.

Yost Typewriters.—The Queen having long since recognised the advantages to be gained from the use of the typewriter, has been graciously pleased to inspect and commend a writing machine fitted with Hindustani characters, manufactured by the Yost Typewriter Company, Limited. It is believed that in the East there is a wide field for the sale of typewriters suited to the requirements of the different Hindustani dialects.

ELECTRIC LIGHTING NOTES.

Australia.—Her Majesty's Opera House at Brisbane is to be fitted with a complete electric lighting installation. The plant includes dynamos, ordered from England, six 2,000 C.P. arc, and 400 incandescent lamps and search lights. Mr. Philange Trackson, A.I.E.E., will superintend the work for Messrs. Trackson Brothers, who have secured the contract.

Bathgate.—The Police Commissioners have appointed a Committee to inquire as to the cost of electric lighting.

Bexhill.—The District Council has now consented to the application of Viscount Cantelupe and another for a Board of Trade electric lighting license.

Balmoral.—The *Dundee Advertiser* says that Balmoral Castle is to be supplied with the electric light. The motive power is to be taken from the Gelder. In the first instance, the electric light will be introduced in the ballroom only, but ultimately no doubt all the rooms of the Castle will be supplied. It is stated that the expenditure contemplated in the meantime is about £1,400.

Belfast.—The District Lunatic Asylum is to be lighted by electricity at a cost of £2,600.

Bradford.—The Corporation accounts for 1894-5 were issued last week, and contain the following satisfactory details regarding the electricity works' revenue account:—The gross income was £11,737, and the expenditure £5,773, leaving a trade profit of £5,964, against which was charged interest and sinking fund, £4,095, leaving £1,869 to be carried to net revenue account, against which was further charged for depreciation of plant and machinery £1,063.

The *Bradford Observer* says:—"The Gas and Electricity Committee has gone so far in its recognition of the necessity of the provision of larger electricity works as to agree, subject to the sanction of the Town Council, to purchase a large plot of land for new works. The committee has lately been seriously considering whether it would not be necessary to shut off the supply of electricity to all Corporation establishments at Christmas time; but a recent improvement in the working of the apparatus will enable the committee to avoid that inconvenient proceeding."

Blackpool.—The *Blackpool Times* says there was another stormy meeting of the Town Council in Electric Lighting Committee on 17th inst.

Bridgwater.—A committee has been appointed by the Council to take into consideration the question of lighting the town with electricity, or purchasing the gasworks, if favourable terms could be arranged.

Brazil.—Among the many towns in Brazil which have recently decided to adopt electric lighting, or are at present engaged in considering the matter, are, Braganea, Recife, Magymerim, Pernambuco, Riberao Preto, Amparo, and Santos.

Brussels.—The Belgian Minister of Agriculture and Public Works has arranged with the Municipal Authorities of Brussels, for the latter to supply the electrical energy required for lighting by electricity the various Government buildings during a period of 25 years, at the rate of 6 centimes per 100 Watt-hours.

Broadstairs and St. Peter's.—The District Council the other day granted an interview to Mr. Ellis on behalf of a proposed electric lighting syndicate, and he explained the objects of the syndicate.

Coolgardie.—We are informed that Messrs. Lipman and Vincent, of Coolgardie, Western Australia, have placed a contract with Messrs. R. W. Thomson & Co., of Leigh Street, Adelaide, to instal the electric light throughout the Grand Hotel, at Coolgardie. The plant will consist of an oil engine (11-brake horse-power), a Crompton dynamo, and 120 incandescent lamps of 16 C.P. each, fitted up throughout the hotel. The hotel is a wooden two-storey structure, and contains 50 rooms.

Croydon.—The Local Government Board has sanctioned the Croydon County Council to obtain a loan of £27,500 for the purposes of electric lighting, repayable in 25 years. Active preparations are in progress for commencing the work.

Colliery Electric Lighting.—The Houghton Main Colliery Company, Barnsley, Yorks, have just had put down by Messrs. Crompton & Co., of Mansion House Buildings, London, an electrical plant for lighting the whole of the surface, including the head offices, weigh-houses, workshops, engine-houses, screens, and the pit yard. There are four 3,000-C.P. arc lamps, and two of 2,000 C.P. each, also 200 incandescents. There is a dynamo giving 240 ampères at 110 volts. The machine is driven by a 40-H.P. engine. Concentric wiring is used.

Coventry.—Some little time back two local firms were invited to tender for an electric light installation at the Free Library, but when the tenders were received it was considered that the cost was more than the committee could afford. It has now, however, been decided to put the work in hand at a cost of £140, on account of the damage done to the books, &c.

Dewsbury.—The British Insulated Wire Company are to supply half a mile of cable for house services for the Council.

Dundee.—The lighting of the High Street is to be improved by introducing a better glass into the electric lamps.

The electric lighting for the Free Library and Baths at Lochee has been contracted for. The contract price was £139 15s., which was considerably less than the original estimate. Tenders for the supply of coal for electrical purposes have been remitted to the Convener and ex-Provost Brownlee with powers. A contract for pilot wires for the electrical department has been entered into at a price of £106.

Dutch East Indies.—The concessions which were recently granted for the electric lighting of Batavia and Buitenzorg, have been acquired by the N. I. Electriciteits Maatschappij, of Amsterdam.

Edinburgh.—The report of Prof. Kennedy, which we published in a recent issue, has been unanimously adopted by the Corporation.

Electric Light for Cycles.—It is stated that the cycles in use in the French Army are to be provided with electric lights.

Fareham.—The result of the poll taken last Saturday was declared as follows:—For purchasing the works, 431; for paying the damages, 235; majority for purchasing, 196.

Folkestone.—An adjourned meeting of the Corporation to take into consideration the proposed provisional order respecting electric lighting was held last week and adjourned.

Glasgow.—The Corporation Electric Lighting Sub-Committee have agreed not to give a supply of electric light, free of charge, for the clock in the tower of St. George's Church.

Grangetown.—A councillor stated the other day that he considered it advisable that the Council borrow £4,000 for an electric light installation, and after discussion, a committee was appointed to fully inquire into the question of an installation for Grangetown.

Hornsey.—The Lighting Committee having considered the referred letter received from Mr. F. A. Glover, of 97, Queen Victoria Street, E.C., in regard to the lighting of the streets and buildings in the Hornsey district by electricity, recommended that he be informed that his application cannot at present be entertained.

Islington.—The Lord Mayor and Sheriffs will open the Electric Lighting Station.

Kingston.—A committee of the Council and the London and South-Western Railway Company are considering the subject of the electric lighting of Kingston railway station. The Town Clerk has received a reply from Major-General Webber, stating that he could not advise Lord Dysart to incur the outlay for an electric main to Ham House, and adding that he was prepared to advise Lord Dysart on any definite proposals the Corporation might see their way to make for supplying electricity in Ham.

Leeds.—A new theatre is proposed for Leeds, a complete electric lighting system to be provided.

London.—Lord Rowton's Model Lodging House for Men in the King's Cross Road, which will be opened during the first week of January, will be lighted throughout by electricity.

Penshaw.—The Parish Council sent a deputation to the Earl of Durham's agents in respect to the lighting of the district by electricity. They, however, in reply, stated that they could not entertain the question of providing electricity, but were open to consider the question of providing gas lamps.

Pitlochry.—In further reference to the scheme suggested by Prof. George Forbes for electric lighting, we understand that he will give full details and estimates in a few weeks.

Shoreditch.—The Vestry has endorsed the action of the Electric Lighting Committee, which had approved the specifications and plans for the electric light buildings and offices, submitted by the engineers, and issued advertisements for tenders for the same.

St. Austell.—The Lighting Committee has been instructed to prepare a specification on which the electric light and gas companies might be invited to tender for the lighting of the principal streets.

Stanton.—Lord Carnarvon has consented to light from 16 to 50 electric lamps of 32 C.P. each at £1 5s. per lamp. These terms the Council has accepted, lamps to be fixed from the colliery to the Board Schools, tenders to be invited for carrying out the work.

Spain.—A concession has just been granted for the establishment and operation during a period of 60 years of a central station at Vera, a small town in Almeria province. Work is at present in hand on the establishment of a central station at Burriana, in Castellon province. The plant, which is being supplied by Messrs. Levi & Kocherthaler, of Madrid, the Spanish agents of the Allgemeine Electricitäts Gesellschaft, of Berlin, comprises a 100 H.P. steam engine and a continuous current dynamo. The distribution is on the overhead three-wire system. The plant at the central station at Tolosa is about to be increased, as is also that at the station at Torrelavego (Santander), two new 45-H.P. steam dynamos being added in the latter case.

Staple Hill (Bristol).—The Parochial Committee has decided to oppose the application of the Great Western Electric Lighting Company for a provisional order.

Tottenham.—We understand that the District Council has resolved to appoint Mr. F. H. Medhurst to report upon electric lighting and dust destructors, at a fee of 50 guineas.

Wakefield.—There was a little discussion regarding electric lighting at the last Council meeting, and the Town Clerk stated that the tenders were accepted, at Mr. Hammond's own suggestion, subject to modifications to be approved of. Those proposed modifications came before the Committee on November 27th, and the further consideration of them was directed to stand over, so that the modifications were not yet dealt with, and, therefore, no formal contract was entered into with anyone, although the firms had been advised that their tenders were accepted, subject to modifications.

Preston.—A proposal to light the Town Hall and Public Hall by electricity, at an estimated cost of £2,024, has been referred back to the Markets' Committee for re-consideration.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Baltimore Electric Locomotives.—A recent report of the Baltimore and Ohio Railroad Company says, in reference to the electric locomotive service in the Baltimore belt line tunnel, that on August 4th last the line was opened to the freight trains of the Company, hauled by the one electric motor which was ready for use. The electric power house at Camden Station, which is to supply power for the electric motor train service in the tunnel, and light for the tunnel, and other Baltimore works have been in successful operation since June last. The two remaining electric motors to complete the equipment of three, will be finished before the close of the present calendar year. The entire freight and passenger service through the tunnel will then be hauled by electric motors, and, in view of the successful operation of the motor in service since August 4th, no doubt is entertained of the entire success of the undertaking, making railroad tunnel service, heretofore so undesirable, as agreeable to the travelling public as that in the open. Electric locomotive No. 2, which was recently received in Baltimore, was tested there for the first time on the morning of November 26th by running it over the line a few trips, having No. 1 in tow for a light load. Prior to shipment it had been given thorough tests for power in Schenectady. During the test everything showed up very well and all the bearings ran exceptionally cool. The controller is of somewhat different type from that of No. 1. On locomotive No. 1 there are two revolving cylinders on which contact pieces are placed as in the familiar type K Street railway controller. These cylinders are placed side by side horizontally and operated by a wheel. Locomotive No. 2, instead of having cylinders, has the contacts placed on the periphery of a large drum standing in a vertical position. The entire surface of the drum, however, is not used. Imagine a drum about 40 inches in diameter divided into quarters. On two of these quarters, diametrically opposite, the contact pieces are placed. The adjoining quarters are cut away to the shaft. This drum or barrel has ball bearings and turns very easily. It is operated by a lever similar to the throttle of a steam locomotive. From off to full-on position the operator moves the lever through a arc of about 90°. There is an auxiliary hand switch conveniently placed for throwing the motors in multiple or series. The reverse lever is at the right side of the controller, and in appearance resembles the reverse lever of a steam locomotive. In fact, if a few gauge cocks and water columns were placed on the side of the controller, a steam engine man would feel quite at home. The reason that the controller of No. 2 was made to operate by a lever instead of a wheel, as in No. 1, is that at first it was doubtful if the operators would like the wheel as well as the lever, but after the past five months' service the operators say that they like the wheel as well, if not better, than the lever. However, it is a matter of custom, and there is practically little difference in the ease of operating the controller by either the wheel or the lever. Everything else about No. 2 is the same as No. 1. Locomotive No. 3, to be used as a "spare," is now being completed by the General Electric Company at their works at Schenectady, N.Y., and doubtless will be delivered in Baltimore before the end of the present year.

City and South London Extension to Islington.—The City and South London Railway Company have deposited a Bill for next session, under which an extension of time is sought until August, 1898, within which to acquire the lands authorised to be taken in 1893 for the extension of their electric railway to Islington. The time for the completion of this extension is also to be extended until August 24th, 1901, which is three years beyond the time originally granted. Power is also sought to acquire some additional property in the Borough, and a clause is inserted empowering the company to construct the station proposed to be made in connection with the Islington extension, at Lombard Street, in any form that the company think fit, instead of the "cylindrical form" in which they are at present bound to construct it by their Act of 1893.

Electric Traction in France.—A new line of electric tramway is to be put in operation in Paris on January 1st. The new line, which is about 7 kilometres long, runs from the Place de la Republique, in Paris, to Romainville, and is on the Claret-Vuilleumier underground conduit system. The central power station is situated at Les Lilas, and comprises four steam dynamos, each of 200 H.P. A company has lately been formed to construct and operate an electric tramway between Lyons and Champagne.

A concession has just been granted for the establishment and operation of an electric tramway between Oullins and Saine-Genis-Laval (Rhone). It is proposed to construct several lines of electric tramways in the town of Morbihan.

Electric Traction in Germany.—The question of electric traction is being considered by the municipal authorities of Solinger. Plans have been submitted by four of the leading electrical engineering concerns. The municipal authorities of Coblenz have given their approval to a scheme for the construction of an electric tramway between the Rhine Railway Station, in Coblenz, and Ehrenbreitstein. It is proposed to construct an electric tramway at Neumarkt, Silesia, between the railway station and the town.

The Allgemeine Electricitäts Gesellschaft, of Berlin, has acquired the horse tramways at Görlitz with the view of converting them into electric lines. The Berlin-Charlottenburg Tramways Company proposes to construct a new line of electric tramway between the Branbenburg Gate, in Berlin, and the Kaiser Wilhelmstrasse. The projected line will be on the Siemens and Halske conduit system.

Electric Traction in Austria.—Messrs. Schuckert and Co., of Nuremburg, in conjunction with two other firms, have undertaken the construction of the Gosau electric railway, near Linz. The line will be about 60 kilometres long.

Electric Traction in Italy.—Plans are being prepared for a projected electric tramway between Tarcento and Udine.

Electric Traction in Hungary.—A system of electric tramways has recently been put in operation in the town of Pressburg by Messrs. Ganz & Co., of Buda Pest. The lines are about three miles long with a gauge of 1 metre. The plant at the generating station comprises two Dürr water-tube boilers, two 83 H.P. horizontal steam engines, constructed by Messrs. Nicholson in Buda Pest, and two Ganz dynamos giving 6,600 watts.

Electricity in Mining.—An electric boring machine has just been supplied to the State silver mines at Kongsberg by Messrs. Siemens & Halske, of Berlin. It is expected that by means of this apparatus the output will be increased 20 per cent. without any increase in the present working expenses.

North Staffordshire Tramways.—A meeting of the representatives of Hanley, Longton, Stoke, Buralem, and Fenton, convened by the Corporation on 18th inst., at the Stoke Town Hall for the purpose of discussing matters in connection with the tramways in North Staffordshire. The Town Clerk of Stoke (Mr. J. B. Ashwell) said the meeting had been called to consider the terms of purchase of the plant of the North Staffordshire Tramways Company, under the agreement of which a draft had been submitted to the authorities interested. The company were seeking powers to adopt electricity by means of overhead wires as the motive power on their system, and proposed that at the end of 22 years the various local authorities should have the option of purchasing their portions of the tramways at a reduction of 5 per cent. on the cost for depreciation. The company proposed to construct the generating station at Stoke, and the Highways Committee considered that it would be most unfair to ask the Corporation to take over works, which by that time might be obsolete, upon such terms, in the event of their desiring to purchase the tramways within the borough. The committee also considered the terms unfair as regarded the equipment of the tramways themselves, being of opinion that the terms upon which the tramways should be transferred from the company ought to be settled by arbitration. The meeting had been convened with a view to the authorities taking combined action in the matter. The following resolution was adopted: "That this meeting is of opinion that the various local authorities within the district of the Tramways Company should combine in opposing the clauses proposed to be inserted in the agreement with respect to the purchase of the electric equipment of the company, and that the clause should be altered so as to read that in the event of the option of purchase being exercised that the sum to be paid should be ascertained by arbitration."

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Communication in Turkey.—Several localities situated on the Turko-Persian frontier, in the district of Suleimanieh, are about to be connected by telegraph, as also put in connection with the general telegraphic system of the country. The local authorities of Aleppo are petitioning for the erection of a telegraph line between Marash and Enderin.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—January 15th, 1896. The Belgian Minister of War is inviting tenders for the contract for an installation of electric lighting in the new military school in the Avenue de la Renaissance in Brussels. Tenders to the Ministère de la Guerre, Brussels.

Brazil.—January 25th, 1896. The Minister of Industry of the State of Pernambuco is inviting schemes for the electric lighting of the town of Recife in that State.

Chelsea.—December 31st. Estimates are invited for electric wiring and fittings, in the Chelsea Infirmary extension, Cale Street, Chelsea, for the Guardians of St. Luke, Chelsea. Particulars from Messrs. Lansdell and Harrison, architects, 12, Compton Terrace, Highbury, N., upon payment of £5, which will be returned to those sending *bonâ fide* tenders.

Dublin.—January 8th. Tenders are wanted by Messrs. Arnott & Co., Limited, for the supply and erection of an electric light and power installation to new premises in Henry Street and Princes Street, Dublin. Details can be obtained from Mr. Geo. P. Beater, architect, 17, Lower Sackville Street, Dublin, on payment of £5 5s., which will be returned on receipt of a *bonâ fide* tender.

Durban, Natal.—December 28th. The Corporation invites tenders for the supply, from competent firms, for delivery and fixing at Durban, of steam and electrical plant for the lighting of the borough by electricity. The work will be executed under the direction of Mr. Fletcher, the borough engineer, and Mr. Hadfield, the electrical engineer, at Durban. The plant required includes high-speed engines, dynamos, cables, arc and other lamps, accumulators, &c.

France.—December 31st. The Municipal Authorities of Langeac, a small town in upper Loirè, are inviting tenders for the concession for the electric lighting of the public streets. It is proposed to utilise certain available water power in the district. Tenders to be directed to M. Le Maire, Langeac, Haute Loirè, France.

Roumania.—January 15th. The municipal authorities of Ploesci, Roumania, are inviting tenders for the concession for lighting 46 of the principal streets of the town by electricity. Tenders to be sent to La Mairie, a Ploesci, Roumania.

Russia.—The Mayor of Charkow is prepared to receive tenders for the supply of steam and electrical engines for lighting, as well as apparatus and essential parts, necessary for an installation of electric lighting of 6,000 glow lamps and 500 arc lamps. Illustrated catalogues and price lists, with lowest quotations, to be sent to the Mayor of Charkow, Russia.

Spain.—December 28th. Tenders are being invited by the municipal authorities of Betanzos, a small seaport town in Galicia, for the concession for the electric lighting of the town during a period of twenty-five years. Tenders to be directed to El Ayuntamiento de Betanzos, Spain.

Windsor.—January 1st, 1896. The Corporation invites proposals for taking over and working its electric lighting orders. All proposals to include the erection and maintenance of a generating station upon a specified site, laying down mains, and necessary equipments, with a constant supply of electricity for lighting purposes in the stated area. Details to be obtained from the Town Clerk, Windsor.

Weybridge.—January 1st. Tenders are at present being invited by the District Council for the public lighting. Particulars from Mr. J. S. Crawshaw, surveyor to the Council.

CLOSED.

Cardiff.—The Exhibition Committee has decided that a complete system of electric lighting be obtained for the forthcoming exhibition. The corporation offered to supply all their current up to 100,000 units for £1,400, but the committee has declined the offer, and has now placed with Messrs. Strode an order for 150 arc and 500 incandescent lamps from April 1st to November 7th for an inclusive charge of £3,000, the Exhibition Committee to supply steam, but the contractor to put down engines and dynamos and instal and maintain the lights.

Newport.—The Free Library Committee has accepted the tender of Messrs. Alger & Co. (Newport), for wiring and fitting the buildings for electric lighting at £147, less £10 for old material.

NOTES.

Presentation.—Dr. R. Mullineux Walmsley, lately Professor of Physics and Electrical Engineering in the Heriot-Watt College, Edinburgh, and recently appointed Principal of the Northampton Institute, London, was on Friday, the 20th inst., made the recipient of a handsome gift of books from his past and present students of the College.

Society of Arts.—The following is the syllabus of the forthcoming course of Cantor lectures on "Alternate Current Transformers," by Dr. J. A. Fleming, F.R.S.:—

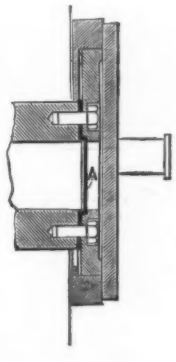
January 20th.—Lecture I.—*The Action of the Transformer.*—Real and imaginary transformers—Transformer diagrams—Alternate current curve tracing—Various forms of curve tracers—Discussion of transformer diagrams—The harmonic analysis of diagrams—The curves of induction and hysteresis—Magnetic leakage—Core and copper losses—Effect of variation of form of the electromotive force curve on core losses—Variation of core losses with temperature—The power factor.

January 27th.—Lecture II.—*The Construction of the Transformer.*—The core—Sheet-iron stampings—Building the core—Prevention of core losses—Selection of iron—The coils—Coil winding—Insulation of coils and core—The case—Ventilation and surface radiation—The terminals—Primary and secondary fuses and switches—Sizes and forms of transformers in practice—Open and closed circuit transformers.

February 3rd.—Lecture III.—*The Testing of Transformers.*—The measurement of the power taken up in an inductive circuit—The theory of the wattmeter—The construction and use of the alternate current wattmeter—Various methods of measuring alternating current motor—The testing of transformers—Testing by curve tracing—Testing by the wattmeter—Differential testing—Practical tests in the sub-station and workshop efficiency curves—Core losses for various sized transformers—Specifications for transformers—Measurement of copper losses and drop—Iron testing.

February 10th.—Lecture IV.—*The Employment of the Transformer.*—Defects in transformers—Causes of failures—Current rushes into transformers—Variation of core losses, with time and temperature—House transformers—Sub-station transformers—Two and three phase transformers—Transformer distribution—Importance of large power factor—Influence of load factor on annual losses—Capacity—Effects in case of large transformer systems—Designs for alternating current stations—Conclusion.

A Micanite Cap Saved It.—Not long since we, *Electrical Engineer* of New York, gave an account of erratic governing of an engine direct connected to a dynamo. The engine, it seems, was erected and ran well for a few days, and then suddenly failed to regulate properly. Some inherent defect in the governor being supposed to be the cause of the trouble, a new governor mechanism was substituted and the trouble ceased, only to be renewed after the lapse of a few days. It was then suspected that the fault might be due to stray magnetism from the dynamo affecting the free motion of the governor parts, and a test showed these parts to be highly magnetised. After trying several expedients to remedy



the evil, the following was adopted, illustrated in the accompanying sketch. A cap of micanite, A, was placed between the eccentric and the hub of the wheel to which the eccentric is fastened, phosphor bronze studs being used for fastening the parts together. This construction afforded complete magnetic insulation and prevented the sticking between the working surfaces of the eccentric, and other parts of the governor mechanism. Since the application of the micanite cap no difficulty whatever has been experienced in the operation of the engine at all loads.

Copper v. Galvanised Steel Tubes.—It is stated by an exchange that all the copper tubes in the English torpedo boat destroyers of the reserve fleet at Portsmouth are to be taken out and galvanised steel tubes substituted. The copper fittings have broken down in a number of the boats that have been tested. How does this affect the prospects of the Elmore tubes?

Edison War-feverish.—We read in the *Sun* of Monday that Mr. Edison told an interviewer the day before—the Sabbath be it known—that if, contrary to his belief, hostilities broke out, he would give his whole energy to the service of his country, and expressed the conviction that by means of the applications of electricity, results would be obtainable which would put a new face on modern warfare, and amaze the English. In another place the *Sun* makes fun of Mr. Edison fighting us with phonographs, kinetoscopes, and other marvels; but seriously speaking, if the "Wizard of Menlo Park," under the ravages of war fever, has really been guilty of such stupid utterances as these with which he is credited, it behoves the English Government to at once enlist the services of Mr. J. Wilson Swan. We would also suggest, in the true interests of the American nation, that Edison's wonderful electrical ideas should be submitted to Dr. John Hopkinson, for it would not be the first time they have amazed the English. The still more extraordinary statements attributed to Edison in Tuesday's *Daily Telegraph*, read just like an extract from a book, "A Yankee at the Court of King Arthur," to which we drew attention some years ago. How Prof. George Forbes must be chuckling to see that his tirades on the average American have been more than established by the events of the past week. It is apparently an easy transition for Edison from "Jumbo" to "Jingo;" but let him take to heart the words of Mr. Gladstone, and fall back upon common sense.

Prize Offered for a Fuse Design.—The *Verband Deutscher Elektrotechniker* is offering a prize, consisting of a diploma and $75, for the best device by which mistakes, such as placing the wrong size fuse in fuse terminals, and the interchanging of fuses except by authorised persons, shall be rendered impossible. The standard sizes of lead fuses adopted by the Verband at its last annual meeting are to be employed. These, according to the New York *Electrical Engineer*, are:—

Ampères.	Distance between centres of fuse terminals in inches.	Diameter of terminal screw in inch.
50	2·8	$\frac{1}{2}$
100	3·2	$\frac{5}{8}$
400	3·8	$\frac{3}{4}$
1,000	4·4	$\frac{3}{4}$

The designs are to remain in every respect the property of the individual, and must be sent in not later than April 1st, 1896, addressed to the Verband at 3, Monbijouplatz, Berlin, N., and marked with a motto. The result will be made public at the next annual meeting of the Verband.

An Experimental Electric Furnace.—In some experiments on the hardening of steel by quenching, G. Charpy describes an ingenious little electric furnace which he made use of (*vide Bulletin* de la Societé d'Encouragement par l'Industrie Nationale). It consisted of a small refractory tube 60 centimetres long by 2·5 centimetres in diameter, within which the specimen was enclosed. The tube was surrounded first by two spirals of platinum wire 7 m. long, and 0.5 mm. in diameter, which were covered with a layer of asbestos, and then surrounded in turn with two other similar platinum coils. The whole was wrapped in asbestos cord, and enclosed in a brass tube, with a current of about 6 ampères and 70 volts flowing through the wires. A constant temperature of 1,200°—1,300° C. could be maintained within the inner tube. The temperature was controlled by altering the current density with the aid of a rheostat. To secure uniformity of temperature the apparatus was constantly rotated about its long axis by means of a small electric motor.

Cleaning Boilers.—How large a number of boilers are run for long periods with no attempt to clean their internal surfaces other than to use occasionally the bottom blow-off, and some of the boilers are provided with blow-off pipes so small, as to be entirely inadequate for the purpose! Frequently, says the *American Miller*, the blow-off pipe is so small, and is used so seldom, that it is quickly filled with sediment when opened, and if not cleaned out soon, it is burned off.

The Auditors of Electric Light Companies.—The following correspondence has been sent to the *Times* for publication:—

Sir,—The attention of the Council of this Institute was directed to an advertisement which appeared in the *Times* of November 29th last, giving notice that at a general meeting of an electric light supply corporation a proposal would be made:—

"That in order to save the trouble and expense of a double yearly audit, it be and is hereby resolved that the auditor appointed by the Board of Trade for the official audit should also act as the shareholders' auditor."

I was instructed to write to the Board of Trade, and to ask whether in their opinion an official auditor of that Board is at liberty to accept the appointment of shareholders' auditor in an electric light company, and to point out that the functions of an official auditor and a shareholders' auditor are not only different, but to some extent conflicting. In reply, I have received a letter from the Board, a copy of which I enclose, and which I shall be glad if you will publish in your next issue.

I am, Sir, your obedient servant,
W. G. Howgrave, *Secretary*.

Institute of Chartered Accountants in England and Wales.

Board of Trade (Railway Department), 7, Whitehall Gardens, London, S.W., *December 18th*, 1895.

Electric Lighting Acts, 1882 to 1890.

Sir,—With reference to your letter of the 5th inst., calling the attention of this Department to a resolution dealing with the question of the audit of the accounts of the . . . . which it is proposed to submit to the next general meeting of the shareholders of the . . . . I am directed by the Board of Trade to state that they hold it to be outside the province of the auditor appointed by them under the terms of the provisional order granted to the company to act as auditor on behalf of the shareholders.

I am further to state that the audit conducted by this auditor is of a different character to that of a shareholders' audit, and has in view different objects, and it appears to the Board of Trade that it rests with the company to determine whether they are acting legally if they entirely dispense with the audit contemplated by the Companies Acts.

I am, Sir, your obedient servant,
Francis J. S. Hopwood.

The Secretary to the Institute of Chartered Accountants, Moorgate Place, E.C.

Presentation.—Mr. C. Burman Callow, after four years' residence at Tring as resident engineer to Lord Rothschild at Tring Park, where he laid down the present extensive plant and installation for the generation of electric power and light—upwards of 3,000 lights—rejoined his old firm, Messrs. Laing, Wharton & Down, of New Bond Street, in July last, and since that time has been engaged in carrying out their contract for laying a complete installation for upwards of 1,300 electric lights in the Brompton Hospital for Consumption. The work is now fast approaching completion, and last Friday the 40 workmen engaged on the work assembled together and presented Mr. Callow with an elegant writing desk in walnut, with silver fittings, as a token of their high appreciation of his ability in conducting the work, and satisfaction at the treatment received by those engaged under his direction.

Warning to Machinery Tenders.—Moving machinery is about as dangerous a toy to play with as a boiler under steam, writes a contributor to *Dixie*, I have seen more bad knocks received from attempting to tighten some moving part than from any other source, and it is strange what men will attempt to do. I had an engineer once whom I was compelled to discharge, because he was for ever adjusting the engine when under motion; he would tighten or loosen eccentric straps, adjust the length of the eccentric rod, the valve stem, try to tighten the crank-pin brasses, with the result that he was for ever getting a bang on the head with a wrench that was knocked out of his hand, and the engine was crippled again and again. Let moving machinery alone. If it needs repairs, it needs them enough to stop for a time, and if it does not need them, then "bide a-wee."

True Resistance of the Arc.—We have received a communication from Prof. Silvanus P. Thompson replying to Prof. Ayrton's comments which appeared in our last issue, but we regret that, owing to the holidays and blocks having to be prepared for the article, we are obliged to hold it over until our next issue.

Discharge of Field Coils.—If a dynamo field coil of many turns be suddenly deprived of its exciting current by opening its electric circuit the result is a pulse or discharge at a maximum E.M.F., often exceeding many times that of the armature to which it supplies magnetism. A series field coil is never open-circuited when it consists of many turns, but shunt field coils are liable to this operation. The powerful pulse of E.M.F. excited by this self-inductive action will exhibit itself most frequently in the shape of a long, flaming arc, but very often it will prefer to strike a path for itself through some weak spot in the insulation of the field magnet or armature. The next time that the machine is started up it is found to be grounded, and, says the *Electric Railway Gazette*, either the armature or field magnet is obliged to go to the repair shop. Field discharges are very often capable of piercing through several thicknesses of mica, and have been known to penetrate as much as $\frac{1}{16}$th of an inch of fibre. To avoid this the shunt field of a dynamo should be discharged very slowly by means of a rheostat. The field switch on a shunt machine is a worse than useless accessory, unless it is properly handled. Careful management in this regard will save many bills in railway power stations, as with machines of high voltage this evil is particularly pronounced.

Welding Temperature.—It has been shown that cast-iron expands to the extent of about 5 per cent. in volume during a small range of temperature while it is passing from the liquid to the plastic state. Since this property of cast-iron resembles that exhibited by water under similar conditions, it has been argued from purely theoretical grounds that the welding of wrought-iron might be explained by attributing to the iron the same property which, in the case of ice, is admitted to be the cause of regelation. In the *Proc. Roy. Soc.*, 1895, lvii., pp. 351-352, T. Wrightson describes some experiments undertaken with a view of investigating this subject. The changes of temperature occurring at the point of welding were observed by placing a thermo-junction consisting of a platinum wire twisted into a second wire of platinum alloyed with 10 per cent. of rhodium at this point. The electric current produced at this thermo-junction deflected a reflecting galvanometer, the movements of which were photographically registered. It was found that a molecular lowering of temperature, varying from 57° to 19° Centigrade, according to the circumstances of pressure and temperature, occurred immediately the pressure was applied to the bar when in the welding condition. These experiments appear to prove that wrought-iron at a welding temperature possesses the same property of cooling under pressure which was proved by Lord Kelvin to exist in freezing water, and on which the property of regelation is admitted to depend.

The Motor and the Watch.—Under this heading, C. C. Haskins, in the *Western Electrician*, enters into an elaborate explanation of the demoralisation to which watches are subject when their owners are in the habit of riding upon "motor cars." The matter should be one of grave concern to all builders of such cars, and it must be borne in mind that magnetism, unlike electricity, cannot be insulated. It may be absorbed, but the absorbing material must be para-magnetic —that is to say, something which can be magnetised. Plates of iron, either in the pure or carbonised state, have been used for this purpose, but it is doubtful whether they are wholly effective, for though the magnetism is absorbed in part, the plate acts more in the capacity of a strainer than of a complete shield. Now, the motor underneath the floor of a car creates a magnetic field in all directions, and this influence saturates the air and everything surrounding it with a decreasing density, as you recede from the poles of the machine. Hence if such cars are to become popular, a means will have to be devised whereby this influence can be confined, or the radius of its action reduced within harmless limits. Here is a chance, then, for some inventive genius to discover such a means, and we may point out that three *desiderata* must be considered, namely, small weight, economy, and efficiency.

Death from Electric Shock.—The *Evening Standard* of Tuesday records the death of Herr Sommer, the chief engineer of the Frankfurt Municipal Electrical Works, who has been killed by an electric current of 3,000 volts pressure.

A New Electrolytic Cell.—Yet another form of electrolytic cell has been devised, and a full description of it may be read in the *Electrochemische Zeitung*, 1895, ii., 153-154. In this cell the cathode does not dip into a liquid, but is brought into contact with a diaphragm, which forms one of the walls of the division containing the anode. This division contains the electrolyte. As the author, J. Hargreaves, points out, the only liquid in contact with the cathode is that which adheres to it through capillary attraction; hence the liquid is bounded by a layer of gas on one side, and this greatly facilitates the use of air or other gases in carrying out reactions. In preparing carbonates, the anodes are scarcely attacked at all, and the E.M.F. used is from 3·0 to 3·5 volts. As the salt in the anode division becomes used up, it is replaced either by a continuous circulation of the solution, or by means of a saturating vessel filled with salt. Scarcely any chlorates or hydrochlorates accumulate in the electrolyte, so that the same liquid can be kept in circulation for weeks.

Electrically Operated Gatling Gun Fires 1,800 Shots a Minute.—The Naval Rapid Fire Gun Board has, says the *Western Electrician*, submitted to Captain Samson, Chief of the Bureau of Ordnance, a report on the trial of an improved Gatling gun. A novel electrical attachment is used with the gun, which permits of about 1,800 shots a minute being fired—a remarkable showing. The motor is attached to the breech of a gun casing by an interrupted screw. The electric current is regulated by a switch, and the connection with the firing mechanism made and broken by a push button held in the gunner's hand. The weight of the motor and casing is 106 lbs.; the length, $21\frac{3}{8}$ inches. The additional length of the gun when the motor is attached is 20 inches. The projection of the central shaft from the breech when the motor is unshipped is $2\frac{7}{16}$ inches. As stated, with the motor in operation, the gun can fire 1,800 shots a minute. The Board says that several hundred shots were fired, the only interruption being due to temporary jams in the gun or feed strips, and that the action of the motor was smooth and regular throughout.

Another Australian Landline Interruption.—Recently we have frequently had occasion to call attention to these vexatious interruptions, the frequency of which show how unreliable is our present means of communication with Australasia. We now learn from Australian papers just to hand, that on the 12th of last month the Western Australia landline was interrupted between Israelite and Esperance Bays. Our readers may recollect that the month before, the trouble took place between Bremer and Esperance Bay. The submarine cable between Roebuck Bay and Banjoewangi is thus rendered ineffectual, and the purpose for which it was originally laid, namely, to obviate the inconvenience caused by the interruptions to the Port Darwin cables, has not been thoroughly met. We are glad to notice, from the source above quoted, that the Pacific cable scheme is making rapid advance, notwithstanding the obstacles and intrigues carried on against it, not only by its French and American, but also by its English opponents.

"A not too Creditable Telegraph Intrigue."—The above is the description applied by the *Daily News* to the Trinidad Island imbroglio. We learn that, according to cable despatches received in New York, December 15th, a meeting of the Brazilian Cabinet was held last Saturday, for the purpose of considering a communication from the British Government to have the question of the ownership of the Island of Trinidad settled by arbitration. The deliberations were protracted, but the Ministers separated without reaching a definite decision. It is stated that Senor Moraes, the Minister of Finance, was the only member of the Government who favoured Lord Salisbury's proposal.

Reduction of Rates to India.—From the money article of the *Standard* of the 23rd, we learn that telegraph communication with Calcutta was interrupted. Under the prevailing conditions of the money market this could not be otherwise than a very grave inconvenience.

Rose from the Ranks.—Mr. Chauncey M. Depew lately visited the Mechanical Department of Cornell University. He found at the head of it Prof. Morris. The latter claimed him as an old acquaintance. "How's that?" said Mr. Depew. "I used to work for the New York Central Railroad," was the professor's answer. "Indeed! in what department?" "Oh, just in the ranks." "How did you get on there?" asked Depew. "I was first a fireman on an engine. That was a tough job, but it led up to the position of engineer. I made up my mind to get an education. I studied at night, and fitted myself for Union College, running all the time with my locomotive. I procured books, and attended, as far as possible, the lectures and recitations. I kept up with my class, and on the day of graduation I left my locomotive, washed up, put on the gown and cap, delivered my thesis, and received my diploma, put the gown and cap in the closet, put on my working shirt, got on my engine, and made my usual run that day." "Then," said Depew, "I knew how he became Prof. Morris." That spirit will cause a man to rise in any calling. It is ambition, but it is ambition wisely directed, seeking to make one's self fitted for higher work. When this is accomplished, the opportunity for higher work is sure to come.—*Scientific American.*

Calcium Carbide.—At the annual meeting of the German Electro-Chemical Society, Dr. Borchers exhibited an apparatus by which he not only succeeded, nearly 10 years ago, in preparing calcium carbide, but also showed that all the oxides which were regarded as irreducible could easily be reduced by the action of carbon. It consists of a small chamber or furnace of fire brick, through the walls of which pass thick carbon rods 40 mm. in diameter. Inside the chamber these are connected by a thinner carbon rod, 4 mm. in diameter and 40 mm. long. The furnace is fed with a mixture of lime and carbon. The action is not electrolytic; the effect of the current being simply to heat the lime to a temperature at which it is reduced by the carbon. An E.M.F. of 12 volts and a current of 90 ampères is used. The current may be either direct or alternating; and by diminishing the length of the thinner rod calcium carbide can be produced with an E.M.F. of only 1 volt, so that electrolysis is out of the question. The reactions which take place are: (1) $CaO + C = Ca + CO$; (2) $Ca + C_2 = Ca\,C_2$. The above reactions are supposed to have been discovered by Moissan and Wilson, but the author refers to publications by Wöhler (1862) and himself (1891).—*Ziets. f. Elektrotechnik u. Elektrochem.; Jour.* Soc. Chem. Ind.

Correspondence.—From Mr. G. L. Addenbrooke we have received a somewhat lengthy communication on "The Institution of Electrical Engineers;" but owing to its late arrival, we are compelled to hold it over until next week.

NEW COMPANIES REGISTERED.

Fort William Electric Lighting Company, Limited (3,067).—This company was registered at Edinburgh on December 17th, with a capital of £7,000 in £5 shares, to introduce and supply electric current into and within Fort William and neighbourhood for the purpose of lighting streets, squares, lanes, public buildings, and for heating, motive power or other purposes, to which electric current can be applied. The subscribers (with one share each), are:—A. McIntyre, Fort William, Inverness; John McDonald, Fort William, Inverness, distiller; M. McKenzie, Fort William, Inverness, writer; D. McNiven, Fort William, Inverness, bank agent; D. McTeish, Fort William, Inverness, bank agent; D. Cameron, Kilmoniwag, Inverness, minister; R. F. Yorke, 51, West Regent Street, Glasgow, electrician. Registered by D. McNiven, Fort William, Inverness.

The Mid and East Calder Gas Light Company, Limited (3,068).—This company was registered on December 17th, at Edinburgh, with a capital of £1,000, divided into 1,000 shares of £1 each, to carry on the business of gas and other light company, as at present conducted, and to manufacture, sell, and dispose of gas, electricity, or other agents suitable for providing light, heat, and motive power to the inhabitants of Mid Calder and East Calder, and of the vicinity. The subscribers (with one share each) are: W. Gray, 2, Royal Crescent, Edinburgh, gentleman; J. E. Stoddart, Howden, Mid Calder, landowner; George Henman, Mid Calder, Mid Lothian, gentleman; James Stevens, Mid Calder, Mid Lothian, schoolmaster; William Martin, East Calder, Mid Lothian, baker; John Hastie, 5, York Place, Edinburgh, solicitor; S. Hislop, Mid Calder, registrar. Registered by John Hastie, 5, York Place, Edinburgh.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Liverpool District Lighting Company, Limited (44,482).—The registered office of this company was, on November 16th, removed to 9, Cook Street, Liverpool.

Lighting Corporation, Limited (44,648).—This company's statutory return was filed on December 5th. The capital is £275,000 in £1 shares (25,000 preference). Seven ordinary shares have been taken up, and £7 has been paid.

G. E. Belliss & Co., Limited (39,411).—This company's annual return has just been filed. The capital is £150,000 in £10 shares (5,000 preference). 4,100 preference and 6,270 ordinary are taken up, and 4,098 preference have been issued as fully paid. £10 has been called on two preference, and £5 per share on the ordinary, and £31,370 has been paid.

New Phonopore Telephone Company, Limited (44,654).—This company's statutory return was filed on December 4th. The capital is £10,000 in £1 shares (1,000 founders'). 5,031 shares have been taken up, 10s. per share called, and £2,515 10s. paid.

Newmarket Electric Light Company, Limited (44,450).—This company's statutory return was filed on November 6th. Nine shares have been taken up out of a capital of £30,000 in £10 shares, and £90 has been paid.

New-Mayne Electric Rudder-Motor Syndicate, Limited (43,150).—This company's statutory return was filed on December 2nd. The capital is £20,000 in £10 shares, and 879 have been taken up. 807 have been considered as paid, and £8 called on 66, and £10 per share on 6, and £588 has been paid.

CITY NOTES.

The Salt Lake and Ogden Gas and Electric Light Company, Limited.—Notice is given that coupons of the 6 per cent. first mortgage gold bonds due on January 1st, 1896, will be paid, on and after that date, at the National Provincial Bank of England, Limited, 112, Bishopsgate Street, London, E.C., or at the Farmers' Loan and Trust Company of New York.

Brazilian Submarine Telegraph Company, Limited.—Notice is given that the coupons on this company's second issue of 5 per cent. debentures, due 31st inst., will be paid, on and after that date, at Parr's Banking Company and the Alliance Bank, Limited, Bartholomew-lane, E.C.

Hobart Electric Tramway Company, Limited.—Mr. G. Carnaty Harrower, of College Hill Chambers, E.C., has resigned his position as manager in London, and the offices have been removed to Mansion House Chambers, E.C.

Anglo-Portuguese Telephone Company, Limited.—Coupons No. 16 of the first mortgage and No. 11 of the second mortgage debentures will be paid, less income-tax, by Parr's Alliance Bank on and after January 1st.

The West Coast of America Telegraph Company, Limited.—The coupons due the 31st inst. on the debentures of this company will be paid by Messrs. Barclay & Co., Lombard Street, London, E.C., and should be left three clear days for examination.

The Yost Typewriter Company, Limited.—The date on which the 5 per cent. dividend will be paid is December 21st, and not January 18th, as previously stated.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 22nd, 1895, amounted to £1,013; week ending December 23rd, 1894, £968; increase, £45; total receipts for half-year, 1895, £22,553; corresponding period, 1894, £22,447; increase, £106.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 20th, 1895, after deducting 17 per cent. of the gross receipts payable to London Platino-Brazilian Telegraph Company, Limited, were £3,677.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation Dec. 18th.	Closing Quotation, Dec. 23rd.	Business done during week ended Dec. 23rd, 1895. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	101 —105	101 —105	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	43 — 45	42 — 44	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	81½ — 82½	79 — 81	83	79½
2,993,560£	Do. do. Defd.	Stock	...	...	...	6 — 6½	5⅞ — 6¼	6⅛	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	12⅞ — 13¼	12⅞ — 13¼xd	13¼	12⅞
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3¼ — 3⅜	3¼ — 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170 xd	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	1/16 — 3/16	3/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	104 —107%	104 —107 %	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅝% §	2 %	8 — 8¼	7⅞ — 8¼	8¼	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	16 — 16½	16 — 16½	16⅝	16½
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	17½ — 18	17½ — 18	17½	17½
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	125 —128	125 —128	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17 — 17½	17 — 17½	17⅛	17⅜
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106	102 —106	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106	103 —106	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	127 —130	127 —130	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	102 —106	102 —106	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	108 —111	108 —111	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115%	112 —115 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	4½%	9½ — 10	9½ — 10	9 13/16	9½
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	16½ — 17	16½ — 17	1 7/8	16½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝% §	8⅝% §	8⅝%	21⅜ — 22	21⅜ — 22¼	22⅛	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	46 — 49	46 — 49	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	106 —110	106 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	...	...	...	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	5⅞ — 6⅛	5⅞ — 6⅛	6⅛	5 15/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15½ — 16½	15½ — 16½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6¼ — 6½	6¼ — 6½	6¼	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —108	106 —108	107¼	107
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4½%	2/16 — 1 1/16	2/16 — 1 1/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	109 —112	109 —112	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	4 — 5	4 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	127	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2½ — 3	2½ — 3	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97	92 — 97	93½	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	...	...	*nil*	5½ — 6½	5½ — 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	102 —105	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103	98 —103	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	9 — 9½	9 — 9½	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 6⅝xd	6½ — 6⅝	...	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	2⅜ — 3½	2⅜ — 3½	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	⅛%	⅞ — 1⅛	⅞ — 1⅛	1	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10½	10 — 10½	10 7/16	10⅜
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½ — 9½	8½ — 9½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	111 —114	111 —114	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	110 —115	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½ — 5⅝	5½ — 5⅝	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	2½%	5 %	5 %	6⅝ — 7½	6⅝ — 7½	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116—119	116 — 119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	12⅝ — 13¼	12⅝ — 13¼	13 3/16	13⅛
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½ — 16	15½ — 16	15 15/16	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	132 —136	132 —136	135½	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8 — 9	8 — 9	...	...
10,000	Do. do. do. 6% Pref., £6 pd., 40,001—50,000	10	...	...	...	8½ — 9	8½ — 9	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅞ — 8⅛	7⅞ — 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	10½ — 11½	10 — 11	10 13/16	10½
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —120	117 —120	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½ — 9	8½ — 9	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8¼ — 8⅜	8¼ — 8⅜	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 9½	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8¼ — 8⅜	8¼ — 8⅜	8⅝	8⅝

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Dec. 18th.	Closing Quotation, Dec. 23rd.	Business done during week ended Dec. 23rd, 1895. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 %§	6 %§	...	1½ — 1⅝	1½ — 1⅝	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %§	6 %§	...	1⅝ — 2⅛	1⅝ — 2⅛	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000*l*	City and South London Railway	Stock	⅝%	⅝%	1¼%	40 — 42	40 — 42	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 %§	7 %§	...	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	1¾ — 2¼	1¾ — 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	...	...	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	...	4½%	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	*nil*	⅝ — ¾	⅝ — ¾	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2 — 2½	2 — 2¼xd	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¼ — ⅜	¼ — ⅜	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅜ — ½	⅜ — ½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼ — ⅜	¼ — ⅜	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	8 — 9	8 — 9	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	13½ — 14½	13½ — 14½	...	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	15½ — 16½	15½ — 16½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	108 —111	108 —111	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	18 — 19	18 — 19	18¾	18
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	101 —103	101 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	11⅞ — 12	11⅝ — 11⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15½ — 15¾	15½ — 15¾	..	..
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	39 — 41	39 — 41	41½	40½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜ — 5	4⅜ — 5	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 189
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—6%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 98—103.

House-to-House Company (£5 paid), 4—4½.

Do. do. 7 % Preference, of £5, 7⅜—8¼.

Do. do. 4½% Debentures of £100, 110—112.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7⅜—8¼; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.

Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼.

London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6¾—7¼.

Bank rate of discount 2 per cent. (February 22nd, 1894).

THE INCANDESCENCE LAMP.*

By A. BAINVILLE.

(*Concluded from page* 591.)

It seems, therefore, that the incandescence lamp tests thus performed should give results that can readily be compared, and if, during their execution, the measurements are somewhat tedious, this duration is sufficiently reduced for the total number of observations not to be greatly increased. This diminution of the duration of the tests does away with the errors due to the variation, after a certain time of the standardised apparatus used, or at least reduces these errors, and also the number of tests of the measuring instruments. From a practical point of view, the short duration of the tests may be of great interest, in the case of a lawsuit, for instance.

In short, whatever mode of testing may be adopted, it must be absolutely independent of the practical conditions of working of the lamps, must bring out their essential qualities, and must not require any conditions that are not easily realised and controlled; above all, it is essential that the quantities to be obtained should be defined so as not to allow of any erroneous interpretation.

Many tests have been published in which none of these conditions have been realised; such tests are of no value whatever. In many others, especially recently, the luminous powers of the lamps have certainly been determined at various times during the tests; but the lamps have not been placed at the beginning of the test under similar conditions of working. Sometimes even the difference of potential at the terminals of the lamps has been increased in certain proportions, without starting either from the same brilliancy or the same consumption in watts per candle.

* *L'Electricien.*

Up to the present, the main object of the tests of incandescence lamps seems to have been rather to verify the figures furnished by the makers than to compare lamps of different makes; or, if this comparison has been made, it has generally been under defective conditions that falsify the results obtained.

In short, if it is quite true that a lamp is better, all other conditions being equal, in proportion as the number of watts expended to furnish the unit of light is smaller, we cannot hope, in practical tests, to equalise either the duration of the lamp, or the variations that the wattage undergoes with the time when the difference of potential at the terminals, or the luminous power, is maintained constant; these are, properly speaking, qualities that have special values in each lamp, and that can only be determined by testing. As to the consumption of electrical energy per candle, it may vary to a great extent in the same lamp, of whatever make it may be; in other words, the wattage of the lamp is a quantity that may be modified at will, within certain limits, by varying the difference of potential at the terminals, and that in itself furnishes no indication as to the quality of the lamp. We can, therefore, in all tests, choose an initial wattage determined beforehand, as we have shown above in the methods of testing that we have described.

The idea is not new, but it has advantages that are useful in practice. Under these conditions, in fact, the variations that this same initial consumption of all the lamps subjected to the tests undergoes in proportion to the time furnish directly important indications as to the comparative value of these lamps, and this independently of the cost of the electrical energy and of the price of the lamp; the best lamp will certainly be the one that preserves its initial consumption the longest. The results obtained by this method furnish other indications that are still more exact; the quantity of light produced at the beginning of the experiment is in proportion to the emissive power of the filament; we have therefore only to measure the length and the diameter of the

filament in different lamps to know the relative value of their emissive powers (we are supposing here that the temperature of the different filaments is the same, which is only approximately true); from a practical point of view, in all cases, the best lamp is the one that, for a given consumption of electrical energy, will furnish the greatest quantity of light per unit of surface.

These various considerations show the importance of this simple modification of the methods of testing generally employed, and the desirability of its general adoption.

Some very interesting studies might be undertaken with regard to incandescence lamps, independently of the tests described above. Even if they possess only a purely scientific interest, they might lead to attempts to introduce improvements into their construction. This consideration gives them a practical interest. We will merely point them out here as a natural sequel to the studies we have discussed in this chapter.

We have seen, in the course of these articles, that the relation between the quantity of light produced, and the corresponding consumption of energy, is not exactly known. It would be very interesting if several experiments were undertaken on all the present makes, in order to determine this relation for each make; for, if it is difficult in the present state of the lamp industry to find a general formula applicable to all makes, there is no doubt that this formula can be found for a make that is uniformly carried out.

On collecting the results obtained by different experimentalists, we might, by choosing those that relate to experiments performed on the most perfect productions, establish a relation that would approximate very closely to that that will be given by all the lamps when the manufacture is sufficiently improved, since the values of the different factors that intervene, degree of vacuum, electric conductivity, emissive power, &c., will then tend to agree for different makes.

These studies would, in any case, be very valuable to makers, whom they would instruct as to the value of their productions, and we should, perhaps, succeed in arriving at something better than the empirical formulæ proposed up to the present day.

The study of the influence of the various imperfections of constructions on the practical qualities of the incandescence lamp might also be undertaken with advantage, and would, besides, tend to facilitate the researches we have just suggested. Tests would thus be rendered easier, and their results more conclusive. For instance, it would be a great advantage to find a practical and accurate method of measuring the degree of the vacuum in lamps. The outflow method gives only qualified results, and these only when the tester is thoroughly skilled in its employment. The MacLeod gauge certainly enables approximate values to be obtained, but this can only be used at the factory before the lamp is quite finished.

This series of articles on the incandescence lamp would not be complete if we did not sum up the special advantages of this mode of lighting, although they are well known. The competition at present going on between this mode of lighting and one of its forerunners, in which considerable improvements have recently been made, gives this enumeration a renewed interest just now.

The advantages of the incandescence lamp may be classed under two heads, the essential and the secondary.

The first are: immunity from fire or explosion, the diminution of heat produced, the absence of the products of combustion.

Amongst the secondary advantages we may mention the simplicity of the lighting, the great elasticity of the working which enables this mode of lighting to be used for quite new decorative effects, the possibility of obtaining various colourings, the facility of installation in many cases, and the economy realised by its use under many circumstances.

We will now glance briefly at these different qualities. As regards security from fire, the incandescence lamp certainly offers the maximum of safety in all cases. If the installation is carefully effected, there is absolutely no danger. As the luminous point is enclosed in a bulb that is hermetically sealed, it can be used confidently in all places where the atmosphere contains inflammable dust or vapours, and in this case it is the only mode of lighting that can be used. Even the breaking of the bulb is unattended with danger, as then the filament is immediately reduced to powder by the sudden introduction of the air; if the bulb is accidentally broken, or burnt in a moment by contact with oxygen; if the bulb is only cracked. Some very curious experiments made at the time of the adoption of this kind of lighting for theatres, showed that it would have to be placed under quite special conditions, in order to burn objects in its vicinity. It is only by wrapping up the lamps that we can burn the combustible materials used to envelop them, and then only on condition that these materials are bad conductors of heat, and possessed of considerable powers of absorption. Light coloured materials stand this test without being altered. A lamp can be broken in gun cotton with impunity. It must be owned that these are extreme conditions, rarely met with in practice. Moreover, in incandescence lighting, we suppress the use of the regulating rheostats that are so often one of the causes of fire in arc-lighting installations.

Lighting by incandescence lamps produces a certain quantity of heat that cannot be altogether disregarded, as, if the bulb of a new lamp can be easily held in the hand when the lamp is of a good make, as soon as the bulb becomes blackened its temperature rises considerably. With large incandescent lights, the heat given off by each lamp becomes considerable. However, as compared with the quantity of heat produced by combustion in the open air, that given off by the lamp may be disregarded in all cases. Thus, with the Auer incandescent gas lighting, or any similar system, this advantage cannot be claimed, and if there is less heat than with the old system, the diminution is due solely to the increased efficiency of the burners, which, in certain cases, enables their number to be reduced; but really, each burner for the same quantity of gas consumed seems to produce a greater quantity of heat, as in this system the burners are of the Bunsen type, and consequently their combustion is more complete.

The greatest advantage of lighting by incandescence lamps, and certainly the most important when a confined space has to be lighted, is the complete absence of the products of combustion given off more or less abundantly by all other sources of light. Here, there is no combustion, in the open air, at least, and consequently no deleterious gases are produced as in the various kinds of combustion on which other systems of lighting are based, and, above all, nothing is withdrawn from the outer air. There is no impoverishment of the air we breathe, owing to the consumption of oxygen necessary to all kinds of combustion, no substitution of carbonic acid or oxide of carbon for this oxygen, no fumes arising from incomplete combustion, tending to vitiate the air, and to form a deposit all round the light. In short, we may say that at present incandescence lighting is the only really hygienic system of lighting.

Incandescence lighting, owing to the capability of the lamps to burn in any position, offers special facilities for decoration, and this is an advantage possessed by no other system.

We can also, with this mode of lighting, obtain very varied colouring in the light produced from the white light of a brilliancy resembling that of the arc to the yellow tints given by gas and oil. For this we have only to choose incandescence lamps whose consumption of electrical energy corresponds to the brilliancy required; it is true that the production of a given quantity of light is dear in proportion as the colouring is deeper, since it is lamps of great specific consumption that give this tint; it is also true that we cannot produce in the same lamp different tints, without distributing through a rheostat part of the electrical energy originally consumed in the lamp; but this advantage does not exist either in the incandescence gas lighting, and again this latter can only furnish a special colouring peculiar to the substance which is rendered incandescent; and this peculiar tint is sometimes rather disagreeable, as, for instance, the ghastly light produced by the Auer hood.

The simplicity of the installation required for incandescence lighting, and consequently, the little expense involved, the absence of a special staff for its maintenance, when we have to do with a small installation with an overhead line and hydraulic motive power, have led this mode of lighting to be adopted in places with the fewest resources, and now a number of little towns, having natural forces at their disposal are lighted by this system, whereas they could not have

established gas works, their consumption being too small to support one. Under such conditions, incandescence is cheaper than petroleum. If in large towns, Paris particularly, this mode of lighting is not used more extensively, this is chiefly due to the high price of the current, to its irregularity which rapidly destroys the lamps, and also to the bad laying of both the principal and private mains causing interruptions in the service or accidents, all causes which are gradually disappearing.

Lastly, the incandescence lamp is available for lighting by batteries and accumulators, a method that is not very practical now, but which may become important if we can find a system capable of producing electrical energy at a reasonable price.

Such are, briefly, the practical considerations in favour of the development of incandescence lighting, and consequently of that of the industry we have been describing.

We will ask the reader to excuse the length of this series of articles, which really only gives a slight idea of this remarkable manufacture, but which will tend, we hope, to extend our knowledge of this industry, which, up to the present, the makers seem to have kept as secret as possible.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

At the annual general meeting held at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday evening, the President, Mr. R. E. B. Crompton, occupied the chair. The report of the Council having been read,

The President remarked that the Institution might congratulate itself upon having assisted in the very satisfactory conference with the Board of Trade alluded to in the report, and then moved "That the report of the Council, as read, be received and adopted, and be printed in the *Journal* of the Proceedings of the Institution."

Prof. Perry seconded this resolution.

Mr. Raworth said, before proceeding to the adoption of the report, he had it on his mind to say a few words. He congratulated the Institution and the Council upon the excellent nature of that report, and upon the general prosperous condition of their affairs; but to him it was a matter of regret that the report had not proceeded to ask the members of the Institution to grant to the Council greater facilities for obtaining the advice and assistance of the members on matters affecting the welfare of the Institution. He approached the subject with a deep sense of responsibility—he did not speak merely upon his own behalf, for he was well assured that he represented the feelings of a large mass of the members of the Institution—and he trusted that his sense of responsibility was commensurate with the greatness of the subject with which he was about to deal. He sometimes wondered whether their various members really rose to a full appreciation of the magnificence of the Institution. It was respectable in its origin, it was remarkable in its progress, and its destiny would be resplendent. They had seen what had been the course of the Institution of Civil Engineers, and it filled their minds with respect, almost with awe, when they considered what a moving force it had been in the civilised world; but that Institution had arrived at, or nearly, at the zenith of its importance and power, whilst the Institution of Electrical Engineers had no zenith, until, at least, they had discovered what was the zenith of electrical science and practice. But it was not the question of prophecy that he was disposed to enter upon that evening. At the head of the Institution they had a great and noble Council, of which they were all proud, and which did honour both to the Institution and to the profession with which it was connected. But there was one great defect about their relationship, and that was that the two bodies, the Institution and the Council, were two separate entities, and each was pursuing its own existence without knowing what were the desires and the aspirations of the other. If he might be allowed to point to an analogy, he might say that they represented a pair of human twins. Their origin was the same; they came upon the scene by the same path, and the dates of their entry upon the world were as close together as the accidents of the circumstances would permit. But from that date forward each led its own life, and developed its own interests according to its surroundings and its own education. They grew up possibly in such a way, that 20 years after nobody would suppose they had had the same father and mother. They were in a somewhat similar position with regard to that Institution. It came into existence some 23 years ago, under the presidency of Mr. C. W. Siemens, afterwards Sir William Siemens. It had a membership of something like 100 members, and had a Council, and that Council had developed into the present Council. That Institution of 100 members had developed into an Institution of something like 1,700 members; but there had been a very slight influx of new blood or of members of Council derived actually from the initiative of members of the Institution. The two bodies had grown up together, but not upon identical lines. There was a very great danger in this. They had not arrived at the point of danger, but it was in the interests of the Institution, as long as there was a conceivable source of danger which might at any moment culminate in an actual, tangible danger, to consider whether there was any possible method of removing that possible source of danger, so that the future history of the Institution might be unclouded. He was extremely sorry to hear it, but it was a fact that in the past, if anybody who took an interest in the progress of the Institution ventured to express his opinion, and that opinion did not happen to be exactly the opinion of the Council, he was liable to be called a malcontent. He knew that epithet had been applied to members in that room upon previous occasions, regarding whom he was prepared to deny that they were malcontents in the broad meaning of that term; that was to say, in the sense that it was impossible to please them. On the contrary, he thought they were very easily to be pleased. He wanted to call their attention to one fact in this connection, because it illustrated his meaning, perhaps, better than any theory. It was within the memory of some of those present that at one time there was a question at issue between the members of the Council and some of the members of the Institution; at all events the Council were prepared to take certain action which a large number of the members did not approve. It seemed to those members very natural that they should ask two or three of their number to call upon the Council and give them a few words of advice, in an informal way, as to what would be the best course to pursue. They would, perhaps, scarcely believe him when he said that they found it extremely difficult to get the ear of the Council at all. Eventually they did get the ear of the Council, and naturally the first question put to them was: "Whom do you represent?" The answer, of course, was that they represented no one but themselves, and whilst they had not an express authority to act, they were perfectly certain of themselves, and nearly certain of everybody else. That was an unfortunate position for a deputation to be in. But if there was a feeling on the part of that meeting that there was a possibility of some risk arising in the future, owing to the fact that the Council was not always thoroughly in touch with the feeling of the members, then they ought to organise some direct means to bridge over the difficulty; and without discussing further the general question, he would suggest that it would be an advantage if the Council had the opportunity of quite privately taking the feeling of the members, through the voice of a special committee. It would be quite naturally urged that they did not want such a committee, because their Council was their representative committee. Of course if that were the case the answer would be complete; but he held that that was not the answer to the proposition. The fact of the case was that the Council consisted of 15 movable members, two vice-presidents, and 13 past presidents, so that there were 17 permanent, stuck-fast members of the Council, who not only had votes, but could vote upon the Council, and only 15 active, moveable members, who had any communication with the members at large, and who were drawn from the body of the members within a reasonable time. He did not think the members of the Institution were generally aware of that fact; he did not think they were aware that whilst in the Civil Engineers a certain proportion of the past presidents did not vote, in this junior Institution the past presidents did vote, so that they had a more vigorous House of Lords than the Civil Engineers; in fact they were the strongest Tories of all. As far as voting power went it did not matter whom they put on the Council, providing the Conservative instinct prevailed, and it could not fairly be said that the Council represented the members. It did not represent them in the sense that a Committee would, if they selected a number of gentlemen from that meeting and asked them to go and talk to the president upon any matter in which the members took particular interest. Now he had had enough of that unpleasant business, which it had caused him considerable pain to allude to. Now he had a much pleasanter matter to turn to. They had had placed in their hands that evening a balloting paper, and he thought that paper must be a source of intense gratification to the members. He found that the Council proposed to elect Mr. Sidney Morse an associate; he thought the Council there had got on to bed rock, for they had chosen an associate who occupied a very exalted position on what he might call the outer ring of the electrical industry. They were not all his clients now, but probably would be some time or other. Mr. Morse occupied pretty much the same kind of position between electrical engineers and the Board of Trade that he (the speaker) suggested an advisory committee should occupy between the members and the Council of that Institution.

The President said Mr. Raworth must confine himself to the subject of the report. The balloting list was distinctly outside the report, and it was inexpedient at that juncture, when the list was being scrutinised, that it should be discussed.

Mr. Raworth said if the president ruled it so he must submit. He could not sit down, however, without expressing his satisfaction, and that of every member who had spoken to him on the subject, on the election by the Council of Dr. Hopkinson—[The President: "Selection."]—the selection of Dr. Hopkinson as president for the ensuing year. There was not one of the gentlemen who sat around that table who commanded greater respect than Dr. Hopkinson. He (Mr. Raworth) knew the whole family, and had done so from his boyhood, and he felt it was no exaggeration to say that if they were entirely bereft of president and vice-presidents, and called in Dr. Hopkinson's mother and all his brethren to fill their places, the Institution would lose nothing in usefulness or in lustiness. In this matter the Council had made a big score, but they had not made it off their own bat. For once they had taken from the glass case in which they usually kept it the big bat of the Institution, with its blade of power fitted on to its handle of common sense, and the result was that they appeared that night in an admirable position. Let them go forward and use that bat, and grace be with them. He would propose this resolution: "That this meeting considers it desirable, in the interests of the Institution, to form a committee to represent the views of the members in consultation with the Council, and such committee is hereby constituted of the following members: Mr. A. A. C. Swinton, Mr. E. Manville, Mr. R. P. Sellon, Mr. A. B.

Holmes, Mr. W. P. T. Fawcus (Manchester), Mr. A. W. Heaviside (Newcastle), Mr. H. C. Mavor (Glasgow), and Mr. J. C. Vaudrey (Birmingham), with power to add to their number."

The President asked whether Mr. Raworth intended his resolution as an amendment to the report, or as a substantive motion.

Mr. Raworth: It practically constitutes an amendment, but if you like it can be put as a separate motion.

The President: Well, say one thing or another.

Mr. Raworth: We will put it as a separate resolution.

The President's motion, that the report of the Council be received and adopted and printed in the *Journal* of the proceedings of the Institution, was then put and carried unanimously.

Mr. Sidney Morse, the honorary solicitor, said he had read the resolution, and he was afraid it was not within the powers of the annual general meeting to do what was proposed in it. The business which that meeting had to carry out was stated in Clause 55 of the articles of association, and provided "that the annual general meeting of the Institution should be that held previous to Christmas, and the business of the meeting should be to receive and deliberate upon the report of the Council as to the state of the Institution, and to elect the officers for the ensuing year." That seemed to be the only business which it was competent for that meeting to transact. If they desired to pass a resolution of this sort, it should be done at an ordinary general meeting, after notice. He took it that the resolution was not designed in any way to alter any of the rules or regulations of the Institution contained in those articles of association, but was merely intended as a suggestion, and, therefore, he thought it might properly be brought forward, after notice, at an ordinary general meeting; but he was afraid it was beyond the power of that meeting to entertain it.

Mr. Raworth: I think, sir, that resolution is within the wording of the constitution as read out.

A Member suggested that the resolution should be sent to the Council with the request that they would consider the best method of bringing it forward at some ordinary meeting for further consideration by the members. That would, he thought, render the legality of the proceedings more in accordance with the articles.

Prof. Perry said the difficulty was that when the resolution was brought forward an idea was given that it might be brought forward either as a resolution or as an amendment. Until the scrutators had spoken, he was still a member of the Council, and he had seconded the resolution for the adoption of the report; but, in all fairness, he thought it was within Mr. Raworth's right to have this matter considered either as an amendment or as a resolution.

The President said it was a very simple matter. They all wanted the same thing. Mr. Raworth, and the gentlemen he represented, wished to have this motion brought forward. They (the Council), as in duty bound, asked their honorary solicitor as to what was the best course to pursue, and what was the legal course to pursue. He informed them that the legal course would be that the matter should be brought forward after due notice at an ordinary meeting. What was the use of ignoring the law on the subject, and flying in the face of skilled advice. He thought Mr. Raworth's object would be best met by giving notice, and having the matter discussed at a future meeting.

Mr. Mavor asked if the honorary solicitor would state whether it would be distinctly illegal to discuss the matter at that meeting. As he understood the object of the meeting, it was to discuss the state of the Institution, and if this did not refer to the state of the Institution, he did not know what did.

Mr. Morse (solicitor) said the purpose of the meeting was [to deal with the report of the Council; therefore any resolution come to should have some reference to what was mentioned in the report. If Mr. Raworth wished his remarks to be taken merely as an expression of opinion, and if other gentlemen wished to express an opinion, he did not think it would be particularly out of order. But he thought it would be out of order to pass a resolution at that meeting. Perhaps the chairman, in his discretion, if time permitted, would allow the discussion to go on.

Mr. Swinton: I understand the honorary solicitor to the Institution to express his opinion that it would be out of order to pass the resolution proposed by Mr. Raworth at this meeting. I would ask him whether it would be out of order to discuss the question.

The President: The honorary solicitor has already said it would not be out of order to discuss it this evening. It rests with you, and if you will go on to discuss it, I shall be very glad to listen to it. The question is whether you will put off the discussion to a further meeting, or whether you will discuss it a little now, and a little later on.

A Member: I do not think you can go on to more interesting things.

Mr. Raworth said he felt they had rather got him in a trap. The President asked him whether he was going to submit his motion either as an amendment or as a resolution. He had a strong objection to carrying an amendment on the report, because that would have the force of a vote of censure on the Council, and would be an extremely unpleasant thing to do; he had been extremely glad to be able to take up the attitude of offering to put it in the form of a separate resolution after the report had been passed. He thought this subsequent movement was going to be a very serious check on the matter he wished to bring forward. He had not accused the Council of having got the information first, and then run the solicitor's opinion off on him afterwards; but the effect was the same. He felt that to go on with this matter now would be to place himself in a very false position.

The President said if Mr. Raworth had been trapped, it was accidentally. He (the President) was not aware of what would be the effect of what he said; they were advised afterwards, and he did not know what the effect was going to be. He had no wish to take an unfair advantage, but it had seemed inconvenient to discuss the thing partially then, and to take it up again afterwards. If the question was one of supreme interest, it might be better to deal with it at once; but he did not think this was a matter of supreme interest. They would get quite as large a meeting to discuss the proposition in the early part of next year, and he was quite ready to put it to the meeting whether they should go on now, or whether they should discuss it later.

Mr. Raworth said if they could not take a vote upon it, he did not think it would be doing any good to go on with the discussion.

A Member said this was decidedly an important matter, and one which could scarcely be decided at one time. It was as well that it should be discussed at once, and that they might consider it in the meantime before it was finally settled. They had to confess that the members as a whole were not in touch with the Council, and *vice versa*. Their intentions were good, but they remained on parallel lines and did not come together. It seemed to him, if they started by appointing a committee to advise the Council, the next step would be to appoint a committee to advise that committee. They had better take a few hints from the Civil Engineers. He thought the Institution was working on the right lines in having on the Council the past-presidents, whose experience was invaluable; but at the same time, if they were to have voting power in such numbers as to be able to outvote the purely elective members, there was the danger of their getting behind the times as an Institution. In electrical matters particularly they must go ahead, and he certainly thought it would be much better if it could be arranged that the past-presidents could not vote; they would then have a greater number of names to choose from for the purpose of filling up the Council, and they would be bringing fresh blood more or less frequently into the Council. Under these circumstances the Council would more ably represent the ideas of the Institution as a whole. If it were possible to discuss this matter to-night so that they might have something to think over, it would be better than having the matter sprung upon them, and dealt with right off that night.

The President: Shall we discuss this matter to-night or not? I think those in favour of discussing have it.

Mr. Mavor asked if, before they proceeded, the honorary solicitor could advise whether it was possible to alter Mr. Raworth's resolution so as to make it legal to discuss it. It was highly unfair to stop a discussion like that after the first speech.

The Solicitor said special provision was made for that in Article 60, which said a special general meeting of the members might be called by the Council for a specific purpose, on the request of 10 members and associates, specifying the business to be transacted. There was a qualification, however, that the discussion must not be intended to lead to the altering of any of the articles of association; to make any alteration in those articles it was necessary that there should be two meetings in the usual way, just as in the case of a public company.

Mr. Mavor: Is it possible to put this to the meeting: whether this meeting desires that the president should call such a special meeting to discuss this question, because if it is competent for this meeting now to invite the president to call a meeting to discuss the question we shall save time, and get on with the business.

The President: I think you do not understand; you have to get 10 members to sign a requisition, and then we must call a meeting within a short time.

Mr. Erskine said those gentlemen who thought it was only necessary to make a little alteration in the constitution of the Council, had rather mistaken the meaning of Mr. Raworth's resolution and his reasons in bringing forward that resolution. There was a very great difficulty at present for any member to bring any suggestion before the Council. Of course, with individual members' knowledge of the feeling of the Institution was confined to his knowledge of his own personal friends, who necessarily formed but a small proportion of the whole list of members, and when the member had found that among his own friends a certain change was desired, he could only in an informal manner approach some member of the Council whom he happened to know, and, as Mr. Raworth had very justly said, that member would naturally ask "Whom do you represent?" Even if he could at that moment remember all those with whom he had discussed the matter, the individual member would only be able to at the best represent a very small clique. That that view should be taken by the Council was only natural. It certainly did seem to him that if a committee were appointed as Mr. Raworth suggested, that difficulty would entirely be got over. Each member of the committee would be, more or less, represented, he took it, by a constituency, or rather would represent a great number of members, and the Council would therefore know that if anything were recommended to them by such committee it was something that was generally desired, and not the feeling of a small clique. He did not think it was possible on that evening, or in any one evening, to bring before the Council all the suggestions which different sections of the members would like to make with regard to the future, and it was highly desirable that there should be a committee in touch with the members to bring before the Council from time to time the various points which might arise in that direction. There was another point which could not be lost sight of. The deliberations of the Council were necessarily private, and were held with closed doors. It was perfectly right that that should be the case. It might, however, often happen that the committee would have to bring before the Council certain matters which they would not like to bring forward in that room at the ordinary general meetings, which were practically public meetings. With the committee such points might be brought before the Council, and discussed in the way in which any matter concerning the Institution was at present discussed by that body.

Mr. Shoolbred said it would be of interest to know how far the practice of this Institution in regard to the voting power of the past-presidents, and the recommendation by the Council of the exact number of members required to fill the places on the Council, differed

from, or conformed to, the practice of other similar societies. He suggested that the secretary should ascertain what was done by the various learned societies in London in these matters.

Mr. Mavor said they were not entitled to quite so much congratulation as they were inclined to give themselves upon the accession of members to the Institution, for it was astonishing what a number of active and energetic members of the profession did not belong to the Institution. This was certainly due to the fact that the large proportion of the members of the Council were completely, or almost entirely, out of touch with the members of the profession. He referred, of course, to the vice-presidents, whose very eminence took them away from those who most, in the nature of things, have the future of the Institution in their hands. The Councils' intercourse with the members was, in his experience, of the most charming and useful nature; but, in asking the Council to open their ears to the desires and requirements of the younger members of the Institution, he did not think they were asking anything which ought not to be considered. The only thing they insisted upon was that the Council should know them better. They knew many of the members of the Council very well indeed, but they desired to be known in return. He spoke for many young members of the profession with whom he was in close sympathy and touch. Mr. Raworth had referred to a deputation which waited on the Council, but he did not state that that deputation took with them the requisite documents signed by the requisite number of members to ask for a general meeting to be called to discuss this matter. He was strongly of opinion that they ought to be given more time, so that they could really understand the meaning of their articles of association. He knew the value of legal advice, but something more valuable than that was to understand sufficient of the law to be able to do without a lawyer. The articles should be put in plain simple English, so that they could all understand them.

Mr. Addenbrooke said it seemed to him that the resolution was sprung on the meeting in a very peculiar manner. There was an obscure letter in the papers stating that a meeting had been held which, apparently, claimed to actually represent the members of the Institution. As a simple member of the Institution, he might say that he never heard anything about that meeting, and it seemed to him that those who attended it had taken a great deal upon themselves. He thought anything of that nature should be approached in the most judicial frame of mind. In another society of a very democratic kind, with which he was connected, the Royal Photographic Society, of which he had been a member for 15 years, he had served on the Council for seven years, and during that period the Society had gone through every phase of the movement they were now starting on in this Institution. There was a discussion at the annual general meeting, with the result that a committee was appointed to revise the laws. The committee went on with the discussion of the laws for nearly a whole session, but notwithstanding all the amendments introduced, the Society was made so democratic in its constitution that almost everything was submitted to the Society, and they were continually coming upon stumbling blocks in almost every direction. The result was, that they had to proceed by the general and liberal interpretation of the rules, by common sense rather than by the mere wording. This practice of referring to the Society on every question led to a serious addition to the expenses; a large amount of printed matter was circulated amongst the members; so much, that eventually most of it was put into the waste paper basket. In the end, the Council became more autocratic than ever; now took no trouble about anything, and they drifted back to pretty much the same position they were in before. Certainly, the election of the Council in that Society was upon a more open basis than this, but he was sure that to rake up the whole of the foundations of the Institution would lead to a lot of useless expenditure and waste. No doubt the Council was anxious to do all it could for the members, and if the members had only been content to proceed in the proper and legal manner by calling a meeting and giving the matter proper attention, they would all have come to the subject with their minds prepared and tempers calm, and probably a fruitful discussion would have resulted. But he would really put it to the meeting whether the discussion, so far, had conduced to the dignity of the Institution, or whether there was any use in continuing it.

Mr. Erskine suggested that a great improvement in the practice with regard to the issue of the balloting sheet would be for the names approved by the Council to be sent out six or seven weeks before the election took place. At present, it was sent out seven or eight days only before the election, and there was absolutely no time for members to organise, or do anything in the way of nominating someone other than those whose names were on the list.

Mr. A. A. C. Swinton wished to support what had been said by Mr. Erskine. He did not think this Institution wished to be guided by the example of a photographic society, such as Mr. Addenbrooke had referred to. Let them rather be guided by the Institutions of Civil Engineers and of Mechanical Engineers. In the Mechanical Engineers, he believed the practice which Mr. Erskine suggested should be adopted here was followed, in sending out the balloting papers some considerable time before the day of election. Under the existing practice in the Institution of Electrical Engineers, members had not time to find out anything about the candidates, and they either voted by return of post to get the matter off their minds, or they did not fill in the papers at all. In any case, a week was quite insufficient for any action to be taken.

Mr. M'Lean said, as a country member, this was the first he had heard of this matter, and he quite agreed with those who had said they should have had some notice that it was to be brought up. He wanted to hear more about it.

The President said there was other business to come before the meeting, and there was only just time to finish it. He thought they understood that notice was to be given immediately for the ordinary meeting for the special purpose of discussing this matter to the fullest extent. He hoped sufficient time would be given so that the country members could be made fully aware of the bearings of this really momentous question, which amounted to this, that the Council was to be supplemented by another body to help it and advise it. This would be decidedly a most radical change in the constitution of the Institution, and it required most carefully investigating and thinking out. He wished at once, on behalf of the Council, to say that it was not fair on the part of Mr. Raworth to bring this matter on the meeting that evening, and then to suggest that the Council had not acted fairly in declaring his resolution one which could not be put without notice. The Council wished to have the whole thing, the discussion and the voting, kept together; that is to say, to take place on the same night. In that case, one long evening might have been given up to it, and people would have come prepared, whereas on this occasion most of those present had come to hear a discussion on the two papers read at the last meeting.

The usual formal votes of thanks to the Institution of Civil Engineers for the use of their lecture hall, and to the various officers, were then carried.

Northern Society of Electrical Engineers.

Discussion on Mr. A. R. Bennett's paper on Municipal Telephony.

(*Concluded from page* 783.)

Mr. Henderson said that they had been taken a long way, but not much had been said about the system employed in this country. He thought the Continental system was very much better than ours, and that the system adopted by the New Telephone Company was better than that of the National. Mr. Bennett did not go into the details of the Trondjhem system, but he presumed it was something after the style of the New Telephone Company, that was to say, they probably had separate service wires, or calls for the operator.

Mr. Clibehugh: There was one question he would like to ask. Mr. Bennett stated that when the trunk lines were taken over by the State, the charge for their use would be increased. He would like to know the reason for this. It certainly seemed to him that if the charges were to be still further increased, telephonic communication, except in one's own district, would become practically prohibitive. We have a heavy incubus in the National Telephone Company, which it seems practically impossible to rid ourselves of, and must therefore look to see what precautions can be taken to ensure a reasonable service. The only sort of control which can be exercised is apparently that of the Post Office, and if the renewal of a license were refused if the service were inefficient, we might expect some reasonable measures of reform being introduced. He did not see how competition could be satisfactorily worked. In Manchester they had had an example of that. He was a subscriber to the New Telephone Company, and although the service over their own system was a thoroughly satisfactory one, he found great difficulty when wishing to speak to a subscriber on the National system, which seemed to proceed from jealousy between the companies. He continually found that subscribers were engaged, and frequently it took an hour to speak to a subscriber on the rival system. The National Telephone Company are a much abused body. There is no doubt that their charges are high, and will probably always remain so; but he did not consider that the system was a bad one. Certain improvements were essential, such as more trunk lines and metallic returns. There was, however, one point, by attention to which subscribers might do much to improve the service, and that is by greater attention to their instruments. Nothing causes greater friction and delay than subscribers refusing to answer. This, in private houses, is sometimes unavoidable, but in offices, inexcusable. In conclusion, he would say that although we should all like a cheaper service, he did not think that the bulk of the subscribers would complain of the charge if the service were only efficient.

Mr. Bennett, in reply, said he was sorry Mr. Edmunds was not there, because it was necessary to take very strong exception to some of his remarks. Mr. Edmunds seems to have favoured the Society with an extract of the evidence given before the late Select Committee by the National Telephone Company on its own behalf, but omitting the cross-examination which showed that many of the statements made were not susceptible of substantiation. Take the statement that 500 of the subscribers to the Mutual Company had to become subscribers to the National Company, also actually the exact converse was the case. These 500 subscribers were already members of the National Company's Exchange, and in order to obtain a prompt and efficient local service, they joined the Mutual Company, also. Mr. Edmunds says that it is not fair to compare a Norwegian town of 30,000 inhabitants with the English industrial centres, but I have done nothing of the kind. What I assert is that the example of Trondjhem is applicable, with very slight modification, to our British town of the same size; for a comparison with our larger cities I go to Stockholm and Christiania. Mr. Edmunds has enumerated the various divisions of Manchester and Salford, and assumed that it would be necessary, under municipal management, to have a separate license, a separate exchange, and a separate set of tariffs and regulations for each district. This sort of thing was made much of before the late Select Committee, but the witnesses from Edinburgh and Glasgow repudiated the notion, pointing out that Edinburgh for instance, serves Leith, Portobello, and other outlying boroughs, with water, with gas, and also in some cases with tramways; and the same state of things obtains in other Scottish as well as English boroughs. It would be the same with a municipal telephone exchange. Edinburgh for example, would take a license for Edinburgh and so many miles around, and you may be sure, in face of the low tariffs and the improved service that the municipality of Edinburgh would be able to afford to its subscribers, that nobody in Leith or Portobello would be foolish enough to refrain from becoming members of the Edinburgh Exchange. They pay their water and their gas rates, and their tramway fares at present to the Edinburgh Town Council, and why Mr. Edmunds should imagine that they would draw the line at

telephone subscriptions I cannot tell. Mr. Edmunds also enumerates the names of various districts and towns around London, and says that all of them are included in one rate. I wonder if Mr. Edmunds is aware of the fact, as I am, that in most of the places he names there are no telephone exchanges at all, and that in some of them there is not even a solitary telephone wire, although, in the majority of cases, the respective populations far exceed that of Trondjhem. Mr. Edmunds says further that the Norwegian system is not being worked under the condition of a limited tenure. In this he is not quite correct; but if he were, what has limited tenure to do with the people who want cheap and good telephones? Mr. Edmunds is evidently a thorough advocate of the National Telephone Company, while I am not an advocate against it. My advocacy simply extends to the right of the public to have an economical and efficient telephone service and the right of the telephone industry to be free in this country; matters which have nothing to do with considerations of limited tenure or with the interests of existing telephone companies. Mr. Edmunds further says that it was shown before the late Select Committee—alleged would have been a better word—that if the National Company were relieved from extraneous charges, that the average annual subscription would be reduced to £6 5s. 11d. It was also shown, he says (although I beg to differ from him) that the present working expenses of the National Company amounted to £6 4s. 7d. per line. I should like the Society to compare this statement with that made on the same point by the National Telephone Company to the Manchester Town Council when negotiating the agreement which has been mentioned during the discussion. According to Alderman Hilling, as reported in the *Manchester Guardian*, the National Telephone Company stated that out of £10 received from subscriptions, £8 went in expenses, £1 to Government, and there remained only £1 for dividend and renewals. This makes the working expenses per line more than £9, while the Select Committee was told that the amount was £6 4s. 7d. per line. Which of these two statements is correct? Both cannot be, yet the authority is the same. The fear expressed by Mr. Edmunds that the Mutual Company would have quickly reached the bankruptcy court was superfluous, as they never could, by any possibility, have done so. In estimating the average subscription of the Mutual at £4 12s. 2d. per line, that figure is arrived at after payment of the Post Office royalty, so there is nothing unfair in this comparison. Mr. Edmunds states that the whole of the outside plant of the late Dundee Company of the late Mutual Telephone Company has had to be taken down and renewed. Mr. Edmunds is wrong here again. As regards the Mutual Company's plant, it is still up and still working, as there are over 1,000 subscribers still connected to the exchange. As regards the Dundee and District Company's plant, it is true that much of it was taken down, but not because it was badly constructed and of no use; the reason was quite a different one. He was personally acquainted with the facts of that case, and he could say that Mr. Edmunds was quite mistaken. Mr. Edmunds says that the rate of the Dundee Company was originally £10, and that after it was reduced to £5 10s., the dividend fell from 9 per cent. to 5 per cent.; but the £10 rate of the Dundee Company endured but a very short time, and the development which took place under it was exceedingly small. Practically the whole of the company's good work was done on a £5 10s. rate. That company had to contend against exceptional obstacles, as the patents were in full force during its existence, and its greatest difficulty was in obtaining instruments that it could use without fear of infringement. But, nevertheless, that company paid a dividend of 9 per cent. per annum for the 4¼ years of its existence, and ultimately got its capital back with 40 per cent. added. It also compelled the National Company to undertake never to raise the rate in Dundee beyond a figure which was exactly half of that on which the National subscription stood when the competition commenced. So much for the results of competition. Mr. Marr mentioned the Post Office telephone service, and inquired why only 1,300 subscribers to it could be found in all the United Kingdom. The reasons, he thought, were twofold. Firstly, although the National Company's rates are usually and justly considered very high, they never exceed, outside London, £10 per mile per annum, while the Post Office rate is £14 per mile per annum. There is, therefore, very small inducement for the oppressed to fly to such a sanctuary as is afforded by Her Majesty's Post Office. Secondly, the spirit of Post Office management is inimical to the development of such a business as the telephone. There was no inducement for the Post Office officials to bestir themselves in such a matter, and, as a consequence, they do not put the "go" into the enterprise which is required. But we are practically in the same position in this country, for many people object to wires being stretched over their houses and land, unless they are fixed thereto. In Sweden it is not allowable for a wire to be fixed to any man's property without leave. In reply to Mr. Eckstein, he would assure that gentleman that he fully believed in the capability of British manufacturers to produce telephonic instruments in every way equal to the Swedish and Norwegian, but what he doubted was whether it was possible for Mr. Eckstein or any other British manufacturer to obtain an opportunity of showing what they could do in the present state of affairs. In answer to Mr. Henderson, the system in Trondjhem is an indicator one. Mr. Clirehugh inquired how it comes about that the trunk rates will in some cases be increased next January. The reason is, that the Post Office has made a scale of charges according to distance, which will have the effect of increasing, in many instances, the existing charges of the company. Mr. Clirehugh suggests that complaints as to the bad service rendered by the company should be made to the Post Office, but according to the evidence given by the Post Office before the late Select Committee, the Post Office is satisfied that the service given by the company is reasonably efficient; and so on this important point the Post Office officials find themselves at variance with the public who make use of the telephone. Mr. Browett suggested that a defence association should be promoted in Manchester. The idea is a good one, and there would be plenty of work for such an association to do if it could be formed. Perhaps I might be permitted to supplement Mr. Browett's suggestion by another. Before the late Select Committee the Institution of Electrical Engineers, through the medium of their president, Mr. Crompton, and of Prof. Silvanus Thompson, gave evidence as to the evil wrought to the electrical industry by the present monopoly, and expressed opinions strongly in favour of competition. His suggestion was, that the Northern Society of Electrical Engineers should render help in the same direction. If the Northern Society would appoint a committee to watch the progress of the telephone question, and take such action thereon as might appear desirable in the interests of the electrical industry generally, he was sure that the Society would be performing a good work both for itself and the public. In conclusion, he would like to explain that he had mentioned Trondjhem, because that town was at present the best example of a telephone exchange managed by a municipality. Before the late Select Committee it was said in effect that municipal authorities are not capable of managing a business as a telephonic exchange, and they have heard that opinion re-echoed to-night in Mr. Edmund's remarks. He thought that such an allegation ought to be proved or disproved, and the paper he had given them this evening was, he thought, a very complete refutation of it. After Trondjhem, there remained the greater example of Christiania, and soon the exceedingly important towns of Rotterdam and Amsterdam would be added to the list.

Mr. Browett said there was one remark he should like to make bearing upon what Mr. Clirehugh said, and he must apologise for not having mentioned it before. Would it not be possible, instead of sending isolated complaints in numbers to the Board of Control, to have a powerful Association who could send up all their complaints *en bloc*, with some authority, and thus possibly bring some real pressure to bear upon this monopoly, have all their grievances redressed, and the system generally improved. He was a Mutual subscriber, both at his house and works, and it was really astonishing how the present conditions victimised them. For six months they had almost rendered it impossible to use their telephone when speaking over the National system. He paid for the use of the National; but practically he could not use it, and as regards the expense, that was not all important. There was nothing he would more like to see than for it to be handed over to a monopoly or otherwise; that would really give us efficiency. The multiplicity of systems was undoubtedly a fault. The Post Office, he believed, are only going to grant licenses to those companies with a metallic circuit. That would be a great blessing. They would then probably have as good intercommunication as they had on the Mutual system, and therefore he thought that it might be worth the consideration of a large society like this to bring to bear some organised opposition to the monopoly which even a government could not afford to neglect. If such a thing were done, it was probable that they would ultimately reap the benefit of the greatest invention of the age; but at the present time it appeared to him further off than ever, except for slight improvements in the details and in its working. It has been said that "'Tis better to have loved and lost, than never to have loved at all;" but this surely is a case in which this sentiment does not apply, and it would have been better not to have known the telephone at all than to have known it sufficiently to appreciate its possible advantages, and then to have it snapped away, or practically denied us.

THE UTILISATION OF WIND AS A MOTIVE FORCE.

For many centuries wind has been used in the countries of the old world as a motive power. In some of the low lying lands of Central Europe the lumbering old windmill is still one of the characteristic features of the landscape.

In this country, says the *Scientific American*, the windmill has of late years been greatly improved and brought extensively into use. It is estimated there are over half a million windmills now running, and the annual increase in sales is estimated to be upward of 50,000. They are mainly used for pumping the domestic water supply; in many of the Western States a farm is scarcely considered to be complete unless it can boast of its windmill pump.

In some cases the mills are put to such work as cutting feed for stock, grinding corn, and the various lighter mechanical work of a farm. The success of the improved windmill in America has encouraged the manufacturers to push the trade in European countries, and there is to-day a growing demand in the old world for these very useful and economical machines.

The chief drawback to the use of wind-driven motors is that the power is intermittent and uncertain. It has often been proposed to store up this power, so that the supply can be drawn upon in calm weather. This can undoubtedly be done; but whether such storage can be accomplished with economical results is open to question.

Water might be raised a certain height and stored in tanks prepared for the purpose. But on the basis that 1 horse-power would require the lifting of 33,000 lbs., 1 foot in one minute, it is evident that it would require large storage tanks and much time to lift enough water to provide a supply of any practical value. To this must be added the cost and care of a water motor to utilise this stored-up energy. A simple calculation shows that to furnish a constant supply of 1 horse-power for a day of 10 hours would require the daily storage of 47,000 gallons of water at a height of 50 feet. To accommodate this would require a tank 20 feet square and 16 feet high. To the expense of such a tank must be added the cost of the strong tower which would have to be built to carry at such a height

this load of nearly 200 tons. The cost of receivers and motors for the utilisation and storage of compressed air would in like manner largely neutralise any apparent utility of such device.

To store up sufficient electrical energy to run a 1 horse-power motor for a day of 10 hours would require a set of cells whose weight would be from 1,600 to 1,700 lbs. They would occupy some 20 cubic feet of space; and with the motor, belting, shafting and general fittings complete, the plant would cost about $500.

There would be a certain amount of drawback to the use of this system in the fact that the handling of a battery necessitates some technical knowledge and skill; a consideration that must necessarily limit the range of its application. Of the three systems of storage, the last mentioned would seem to be the best; and with further improvements in the way of automatic devices for regulating the charging and discharge of the batteries, we may look for a more extended use of this system in the future.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co, *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specifications may be obtained of* MESSRS. W. P. THOMPSON & Co., *price, post free*, 8½*d. (in stamps.)*]

NEW PATENTS.—1895.

23,564. "Improvements in alloys applicable for solders, electrical safety plugs, fire alarms, heat indicators, and the like." A. SCHANSCHIEFF. Dated December 9th.

23,653. "Improvements in or connected with electric tram or railway systems." H. ALLEN and O. PEARD. Dated December 10th.

23,658. "Switches for underground electric railways." A. ROSENHOLTZ and H. E. POEHLMAN. Dated December 10th.

23,670. "Improvements in methods of lighting by electric arc lamps." P. H. GUERIN. Dated December 10th.

23,692. "Improvements in electrically operated apparatus for dental purposes." O. H. PIEPER and A. F. PIEPER. Dated December 10th.

23,811. "Improvements in or connected with dynamo generators." W. DE GRAAFF. Dated December 12th.

23,841. "An electrical system and apparatus for synchronously indicating at one or more distant points the distance registered by a ship's log." H. G. BRAIN. Dated December 12th.

23,844. "Improvements in mooring swivels or apparatus for use in connection with lightships, guardships, or other floating bodies that are connected with the shore by electric or telegraphic cables." E. SHORE. Dated December 12th.

23,852. "Diaphragms or partitions for electrolytic purposes formed of carbonates of alkaline earths." S. S. BROMHEAD (La Societe Anonyme des Anciennes Salines Domaniales de l'Est Actien-Gesellschaft, Germany). Dated December 12th.

23,855. "Improvements in electrical switches." THE EDISON AND SWAN UNITED ELECTRIC LIGHT CO., LTD., and C. FARADAY PROCTOR. Dated December 12th.

23,857. "New or improved system of telegraphy and telephony." R. J. CROWLEY. Dated December 12th.

23,865. "Improvements in or relating to thermo-electric generators." A. J. BOULT. (A. Wunderlich, Belgium.) Dated December 12th.

23,892. "Improved means for conveying current to electric motor cars on streets or roadways." W. J. McCAW. Dated December 13th.

23,894. "Improvements in telephones and telephone switches or line selectors." C. L. CLARKE and W. P. THEERMANN. Dated December 13th.

23,922. "Improved means for compensating variations of load at electrical stations." SIEMENS BROS. & CO. LTD. (Messrs. Siemens and Halske, Germany). Dated December 13th.

23,943. "Improvements in the lighting of streets and the like by incandescent electric lamps." R. C. QUIN and H. REASON. Dated December 13th.

23,952. "Improvements in and relating to electric batteries." H. FEWSON. Dated December 13th.

23,976. "Improvements in ball joint fittings in use for electric lighting." J. J. P. BARKER and J. S. BLACKWELL. Dated December 14th.

23,994. "Dynamo-machines for producing alternating electric currents of low tension." A. G. ADAMS. Dated December 14th.

24,013. "Improvements in or appertaining to lamp globes." J. BROWN. Dated December 14th.

24,020. "Improvements in safety fuse devices for electrical installations." SIEMENS BROS. & CO., LIMITED. (Siemens & Halske, Germany.) Dated December 14th.

24,021. "Improvements in switches for connecting two or more electromotors." SIEMENS BROS. & CO., LIMITED, and A. T. BARTLETT. Dated December 14th.

24,037. "Electric programme or bellringing clock." L. H. WATTERS. Dated December 14th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1894.

3,358. "Improvements in electric railway systems." M. WHELESS, Corcoran Building, F. and 15th Streets, Washington, D.C, U.S.A. Dated December 3rd. An electric railway system comprising a car provided with three contact shoes insulated from one another and from the body of the car a source of electrical supply having its opposite poles connected to two of the said shoes respectively, and a motor having one of its poles connected to one of said last-named shoes only, and its opposite pole connected to the third shoe, in combination with track terminals in groups of three, one for each shoe, set at such intervals apart that the contact shoes on the car will reach one group before they leave the other, an all metal service conduit, a feeder from the supply side and a return wire from the return side of said service circuit connected to the two track terminals of each group, through which the motor circuit is completed, normally open contacts in each feeder connection, an armature for closing said contacts, a pick-up magnet for each armature having its energising coil connected to the appropriate two of each group of track terminals, and circuit connections whereby when the car shoes meet a group of track terminals, the energising circuit of the pick-up magnet will be closed, substantially as and for the purpose hereinbefore described. 4 claims.

24,353. "Improvements in brackets for poles or standards for electrical conductors and similar purposes." SIEMENS BROS. & CO., LTD., 12, Queen Anne's Gate, Westminster, and G. W. PERRY, 119, Algernon Road, Lewisham, Kent. Dated December 14th. Relates to a bracket made of two parts only, viz., the bracket proper and saddle so arranged as to be secured together and to the pole by a wedging action. The bracket proper, which partly embraces the pole, has two wings, in which are formed inclined slots. A saddle piece, whose ends are bent to engage in the inclined slots, so that the bracket is effectually secured to the pole by drawing the saddle piece up, its ends, with the inclined slots acting as wedges, causing the pole to be firmly gripped between the bracket and the saddle piece. This saddle piece may either be removable from the bracket, or it may be permanently secured in position by fixing pins in the ends that project through the slots. 4 claims.

1895.

280. "Improvements in and connected with indicator movements for domestic and other signalling purposes." H. OPPENHEIMER, 55, Redcross Street, London. Dated January 4th. Relates to an indicator which will not only show which signalling circuit has been closed, but also how many times this closing has occurred. By this means is indicated both the room from which the signal was sent and also to whom it was addressed. 1 claim.

11,728a. "An improvement in voltaic batteries." W. SHAW, 146, Pleasance, Edinburgh. Dated June 17th. Relates to the use of acetic acid (and in some cases a little sodium alum with the acid) as an auxiliary mixed with the electrolyte in zinc-carbon batteries. It is claimed that this counteracts the bad effects of the evolved hydrogen, ammonia, and other gases, and gives the batteries at the same time a long duration and high power of current prevents crystallisation and unnecessary chemical action of the electrolyte, and promotes a rapid recuperation of the strength of the batteries. 1 claim.

14,014. "An improved electric switch." H. S. JONES (H. SLUEBNER, H. T. PAISTE, and W. G. MILLAR.) Dated July 23rd. Relates to a quick break switch in which two push buttons are provided. When one button is pressed in it makes the circuit and in order to break the circuit the other button is pressed in this causing the first-named button to fly out ready for operation again. 7 claims.

14,031. "Improvements in and relating to electro-plating typing or depositing devices." J. BOSSARD. Dated July 23rd. The invention consists in a means whereby articles hung in a bath are made to travel automatically through the bath, which travel is timed, thereby the deposit will be more even, smooth, and rapid; also a means for connecting the anodes independently so that any one or more can be taken away without interfering with the others. The article to be deposited upon is also caused to make an undulatory movement while passing through the bath. 2 claims.

15,069. "Improvements in and relating to telephony." J. S. BIGGAR, 1,260, Wilcox Avenue, Chicago, Ill., U.S.A. Dated August 10th. Relates to a means for varying the resistance of a telephone circuit which consists of an electro-magnet and in the magnetic path of same is located a portion of the said circuit, consisting of a material such as bismuth, whose resistance to the flow of current is capable of changing its conductivity when cut by lines of magnetic force. 3 claims.

18,146. "Improvements in apparatus for signalling to and communicating with the passengers of a railway train from the locomotive. T. R. SHILLITO. (M. Z. Levey of U.S.A.) Dated September 28th. The invention is for communicating to the passengers of a train from the locomotive in case of accident, &c. The apparatus consists essentially of a platform which fits within an opening in the floor of the cab of the engine, and which said platform when depressed makes circuit with a contact and plate by means of conducting wires communicates with and operates mechanism fitted to each compartment of the train. The compartment mechanism consists primarily of a box-casing fitted with electro-magnets which respectively operate a door and bell. The door is caused to fly open and the bell to be rung which concentrates the attention of the occupants. Various means are adapted to prevent any accidental depressions of the platform in the cab. 3 claims.

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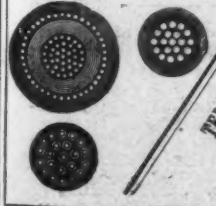

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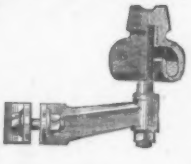

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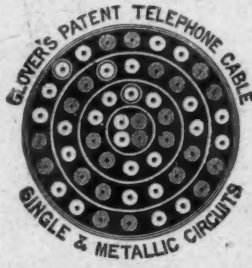

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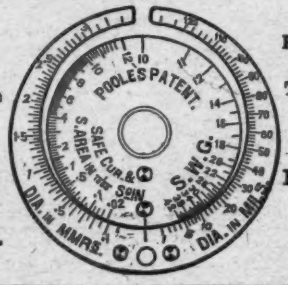

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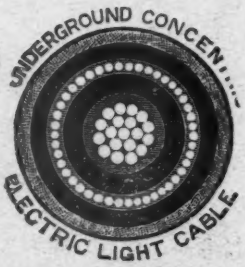

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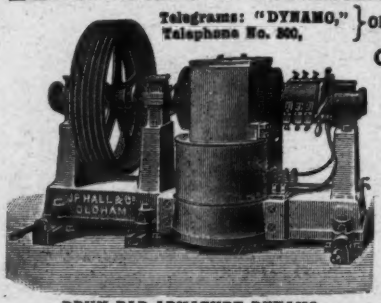

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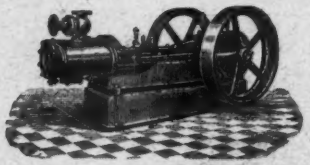

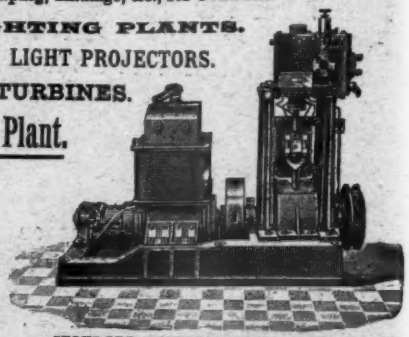

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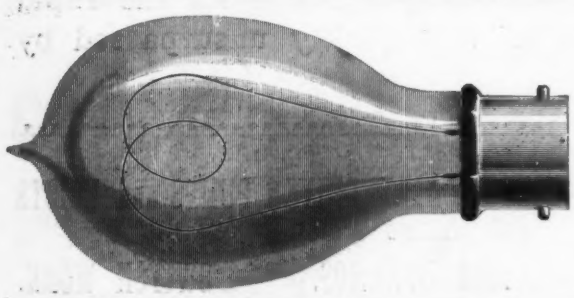

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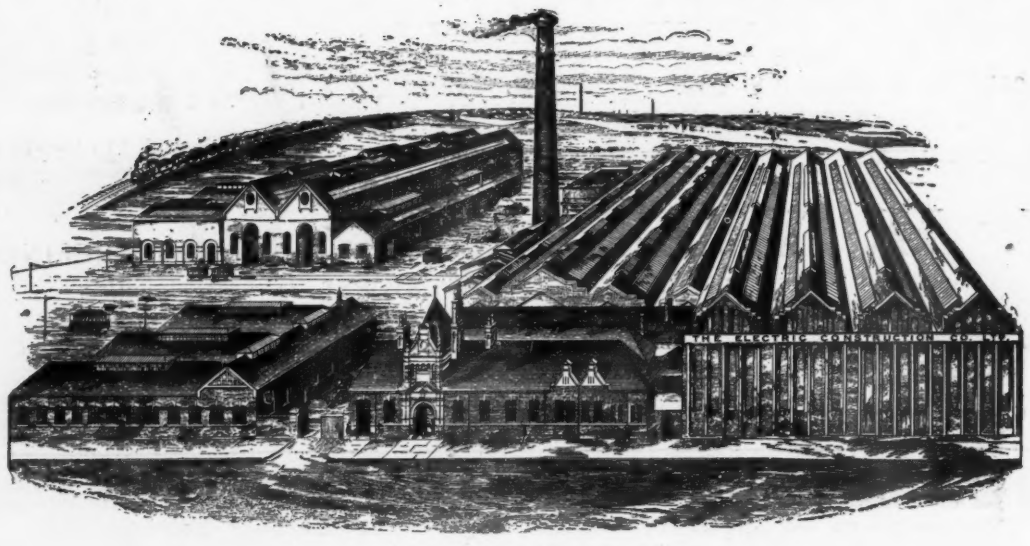

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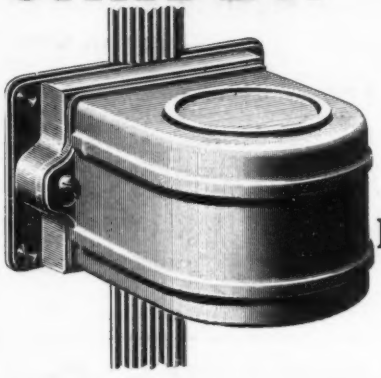

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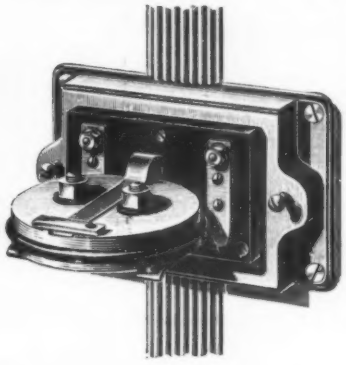

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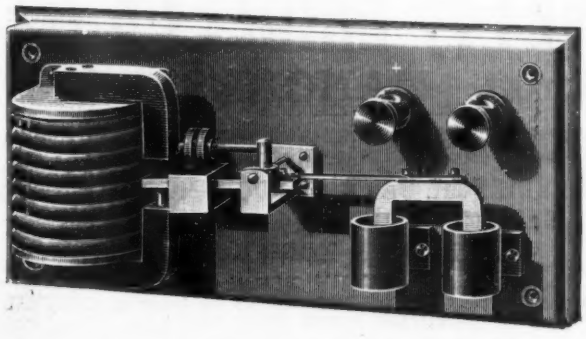

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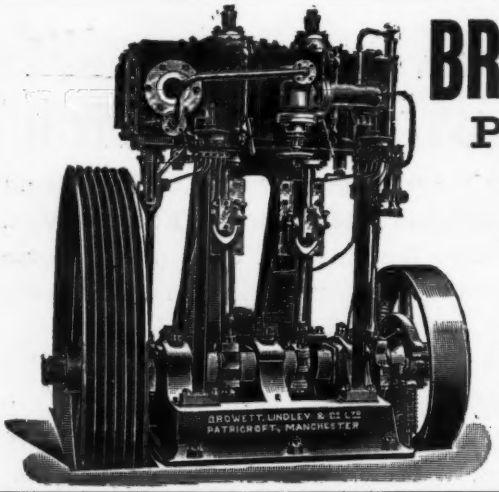

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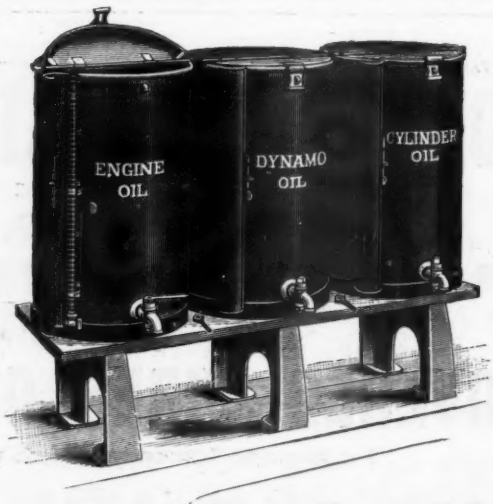

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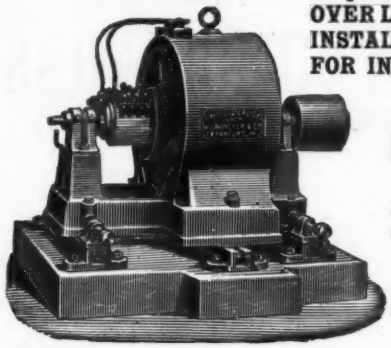

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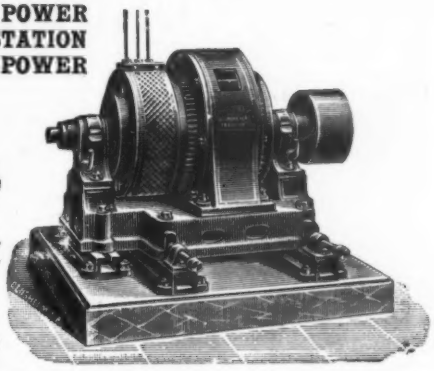

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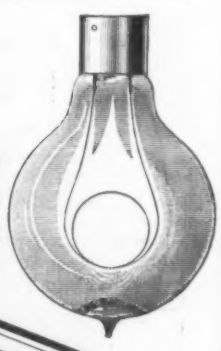

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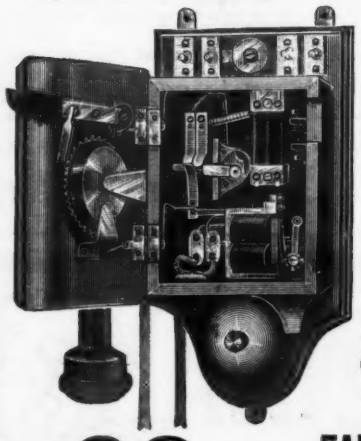

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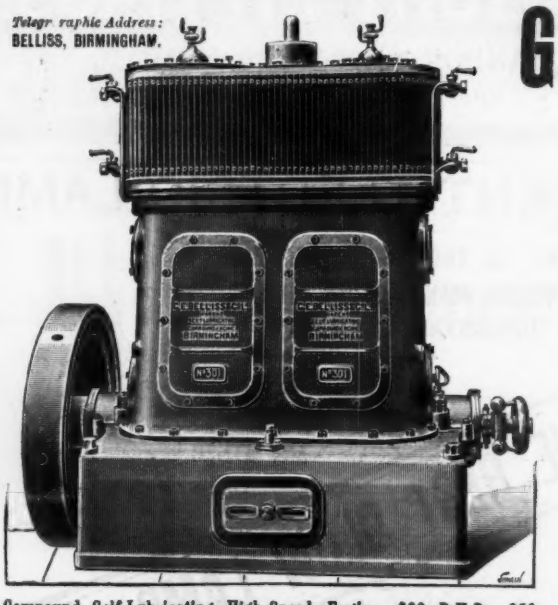

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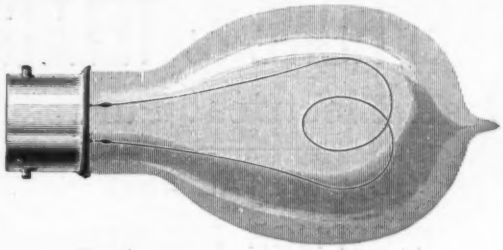

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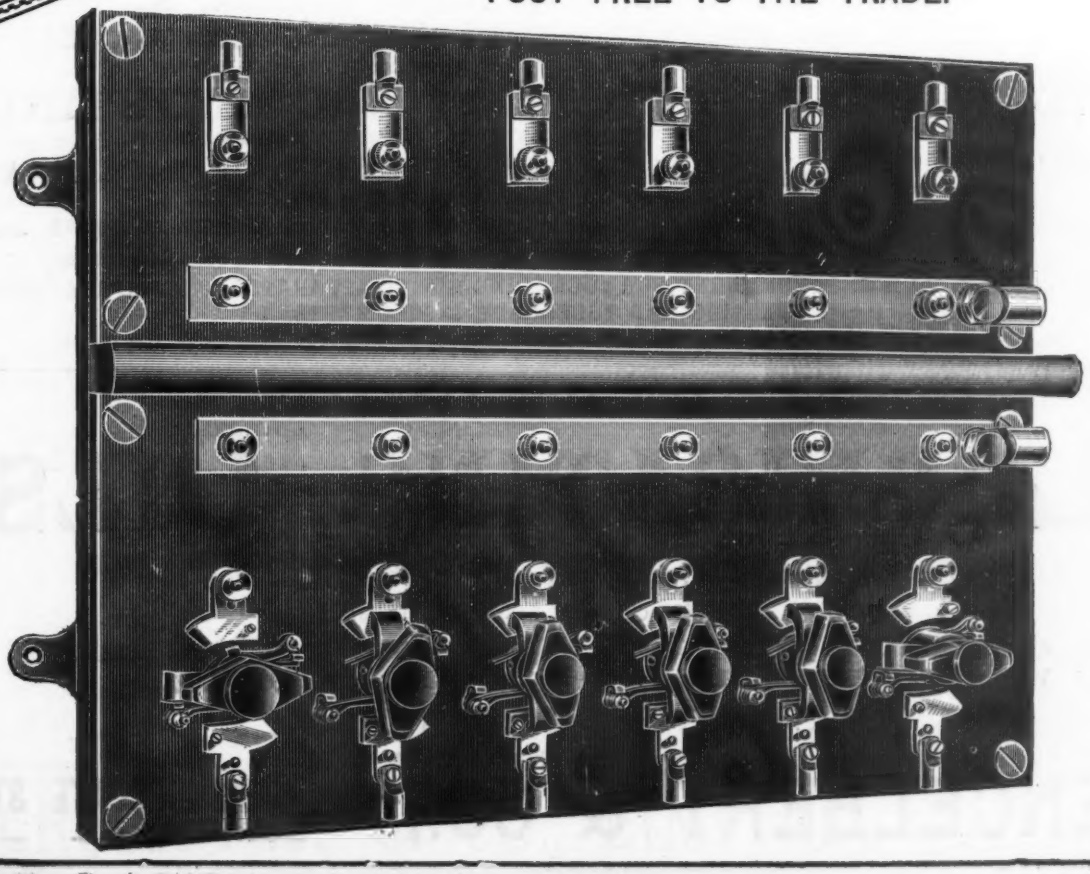

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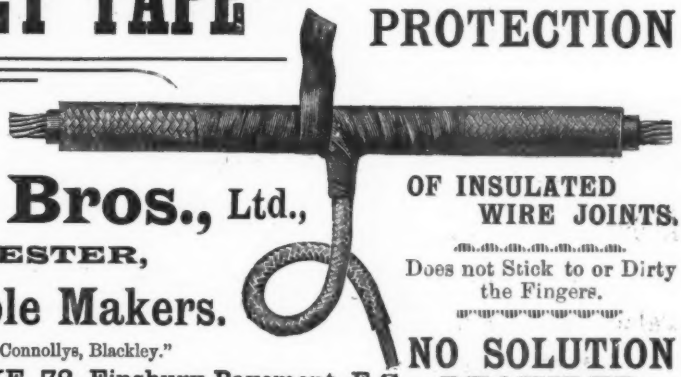

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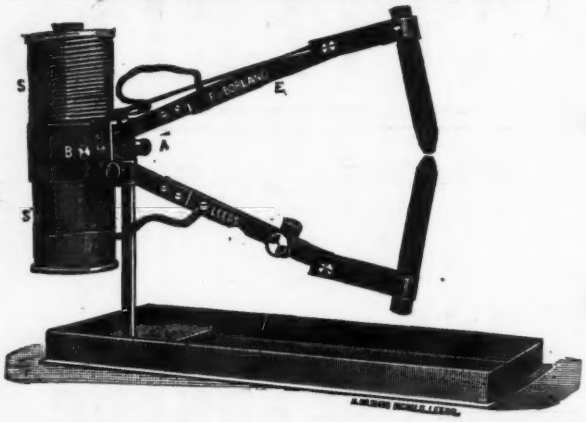

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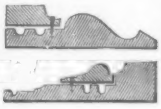

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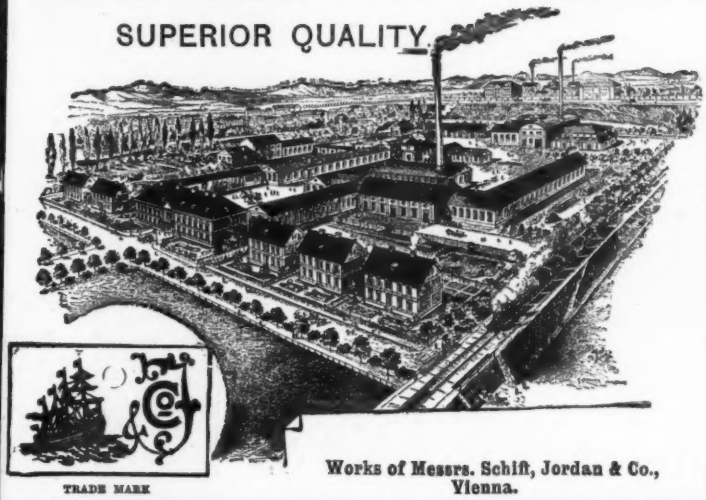

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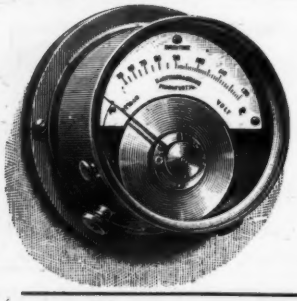

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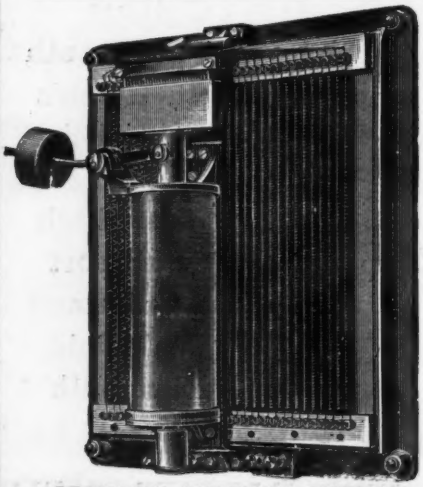

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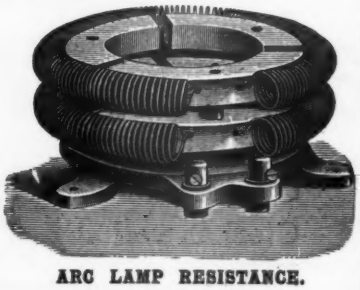

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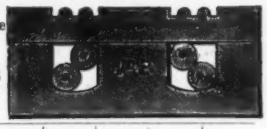

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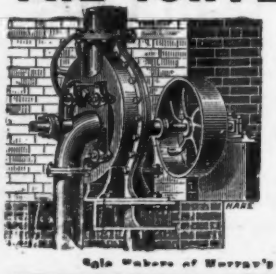

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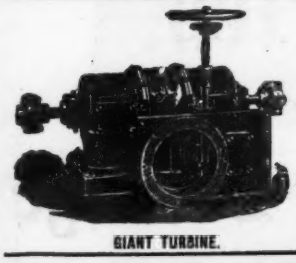

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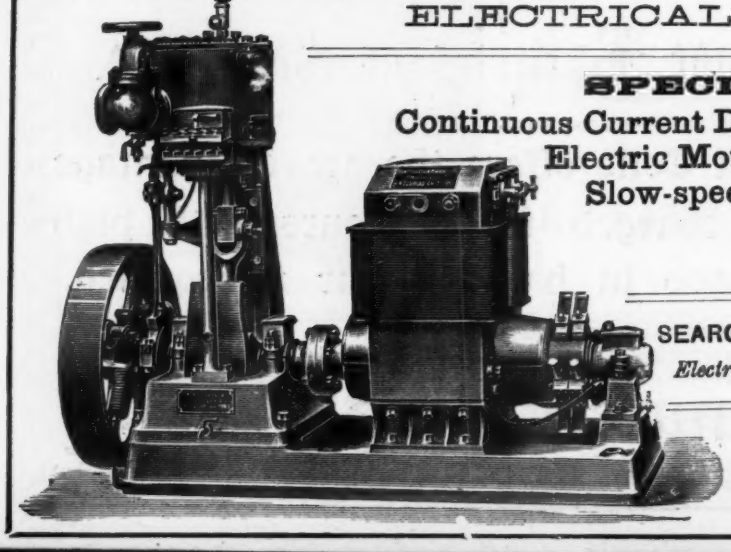

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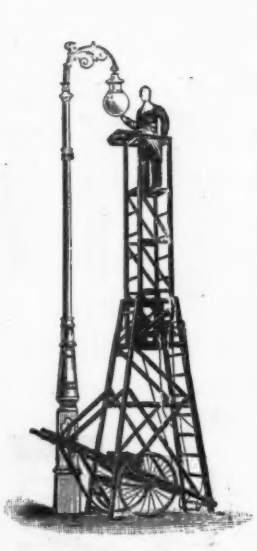

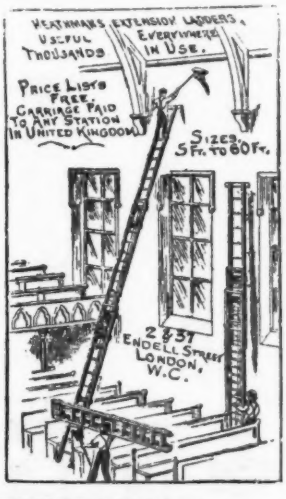
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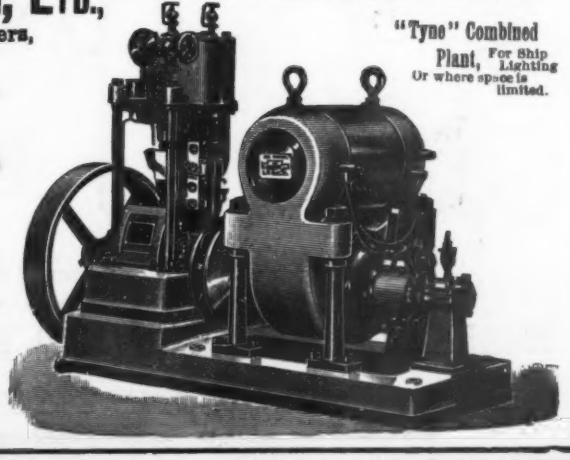

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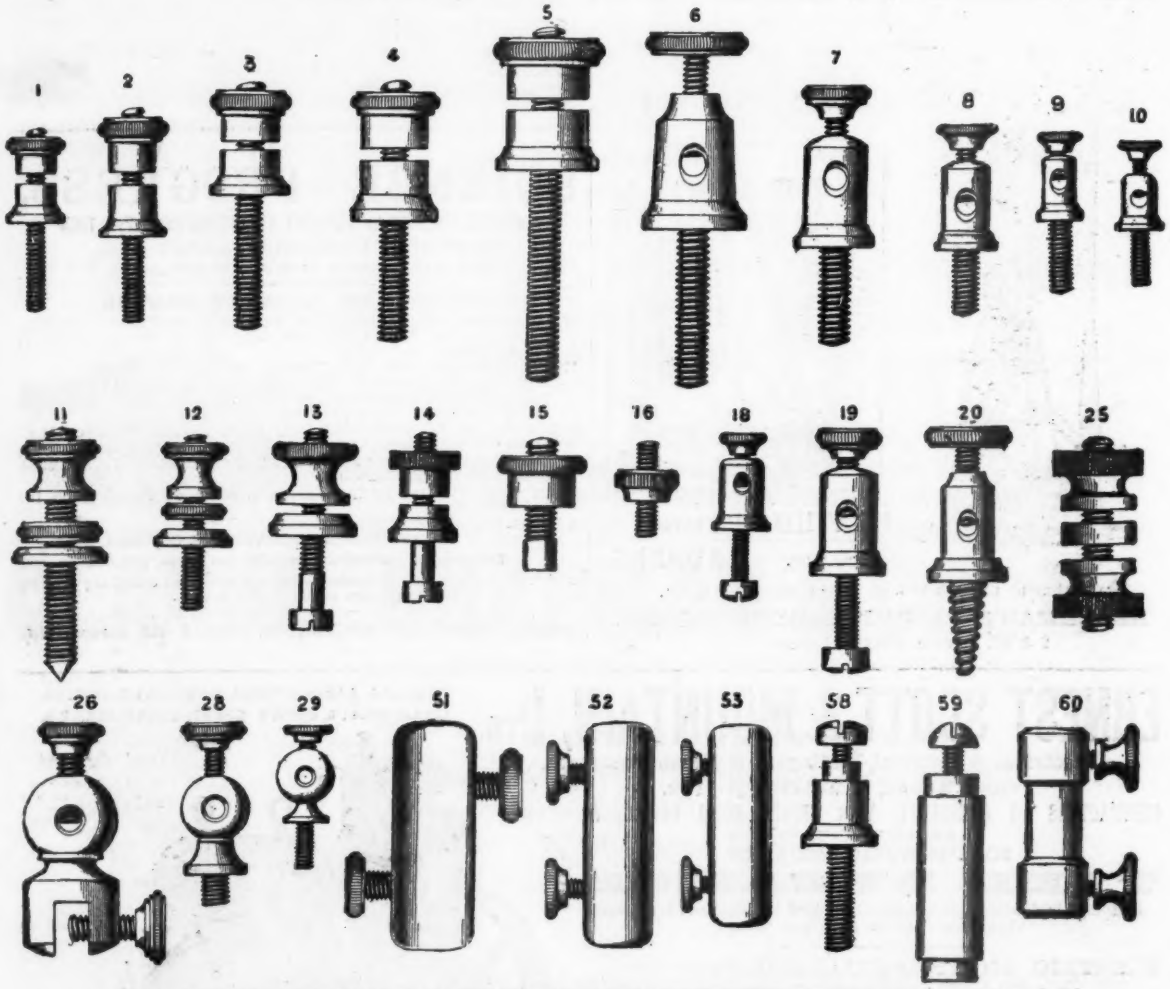

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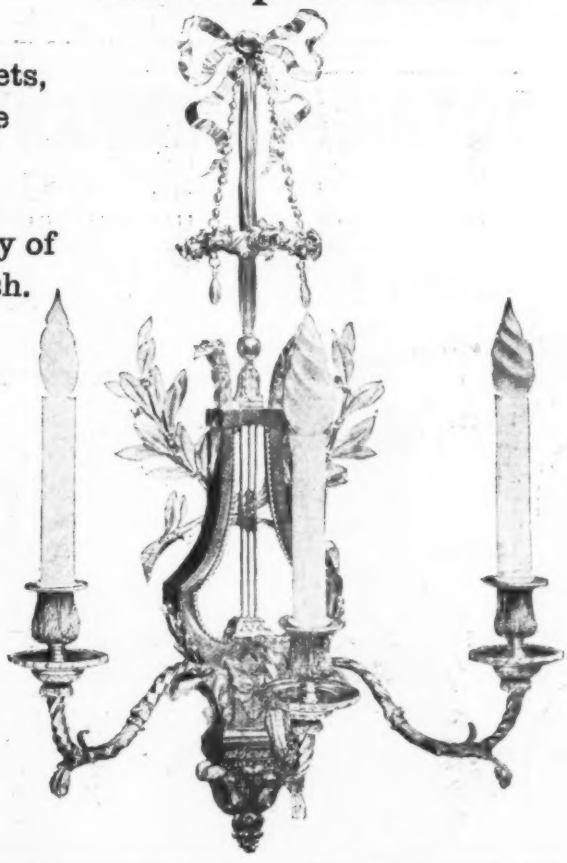

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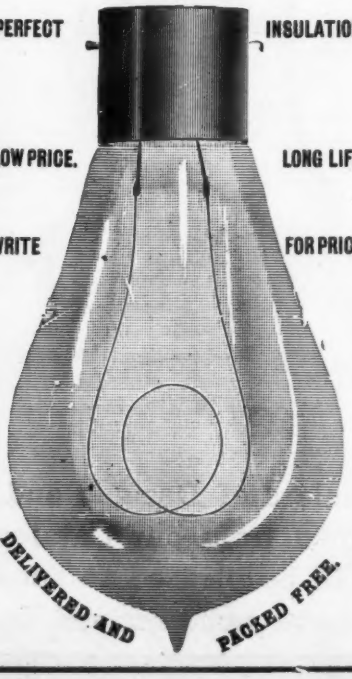

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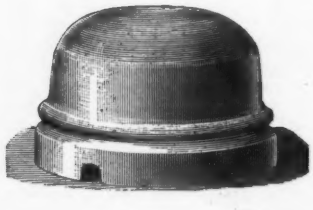

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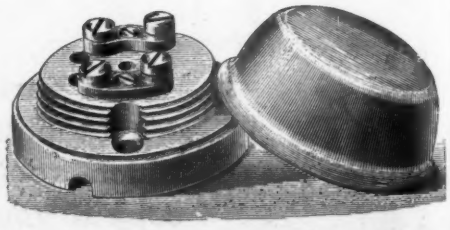

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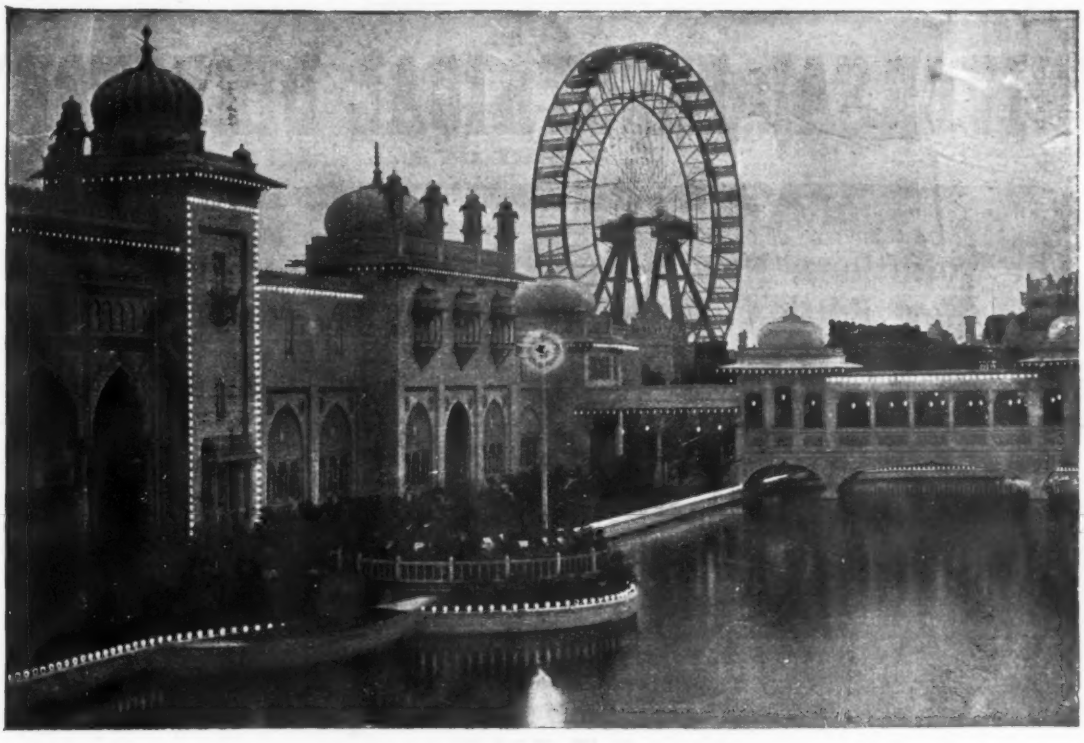

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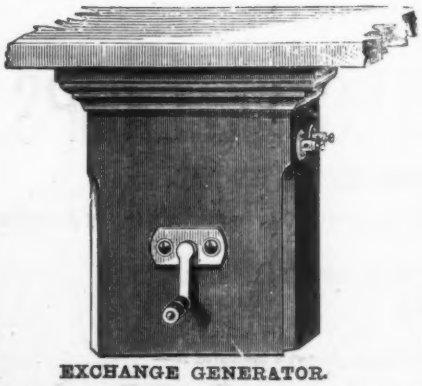

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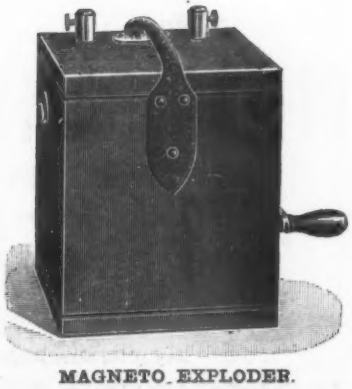

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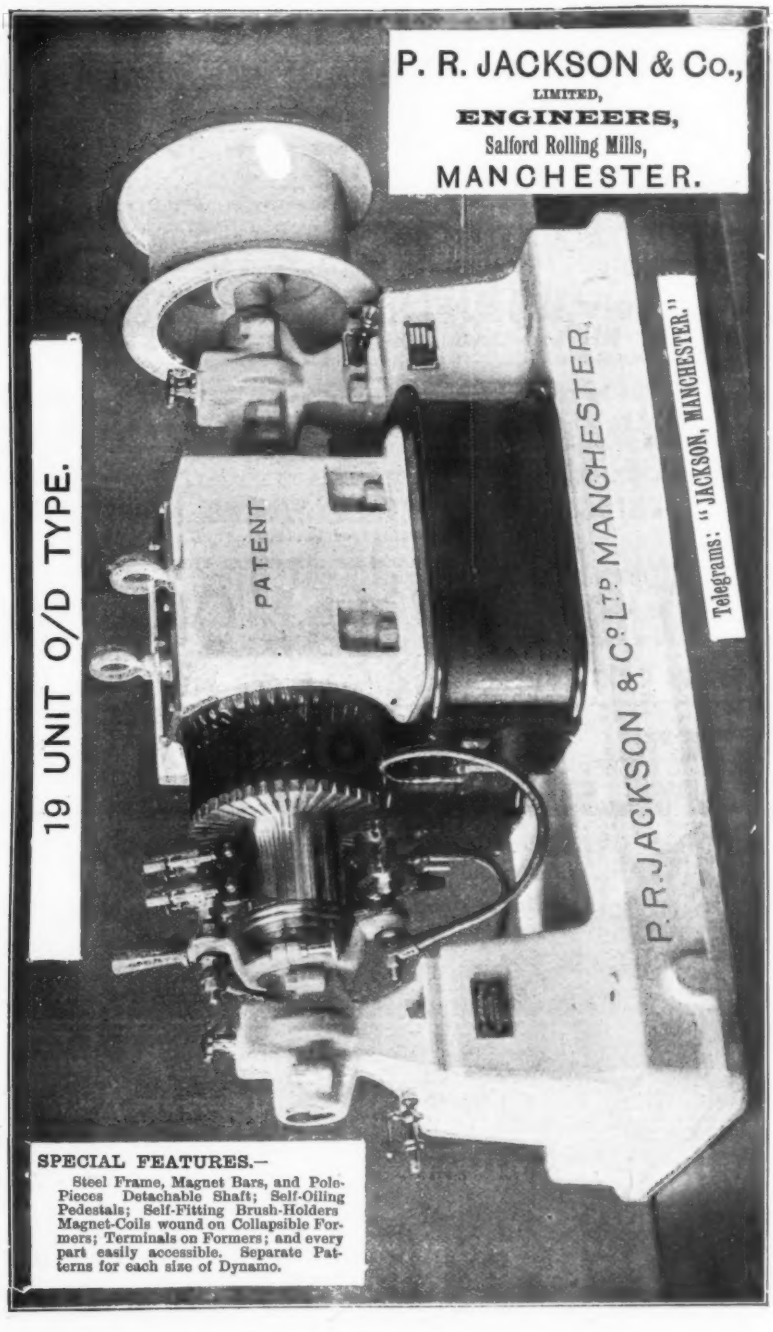
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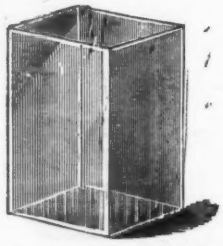

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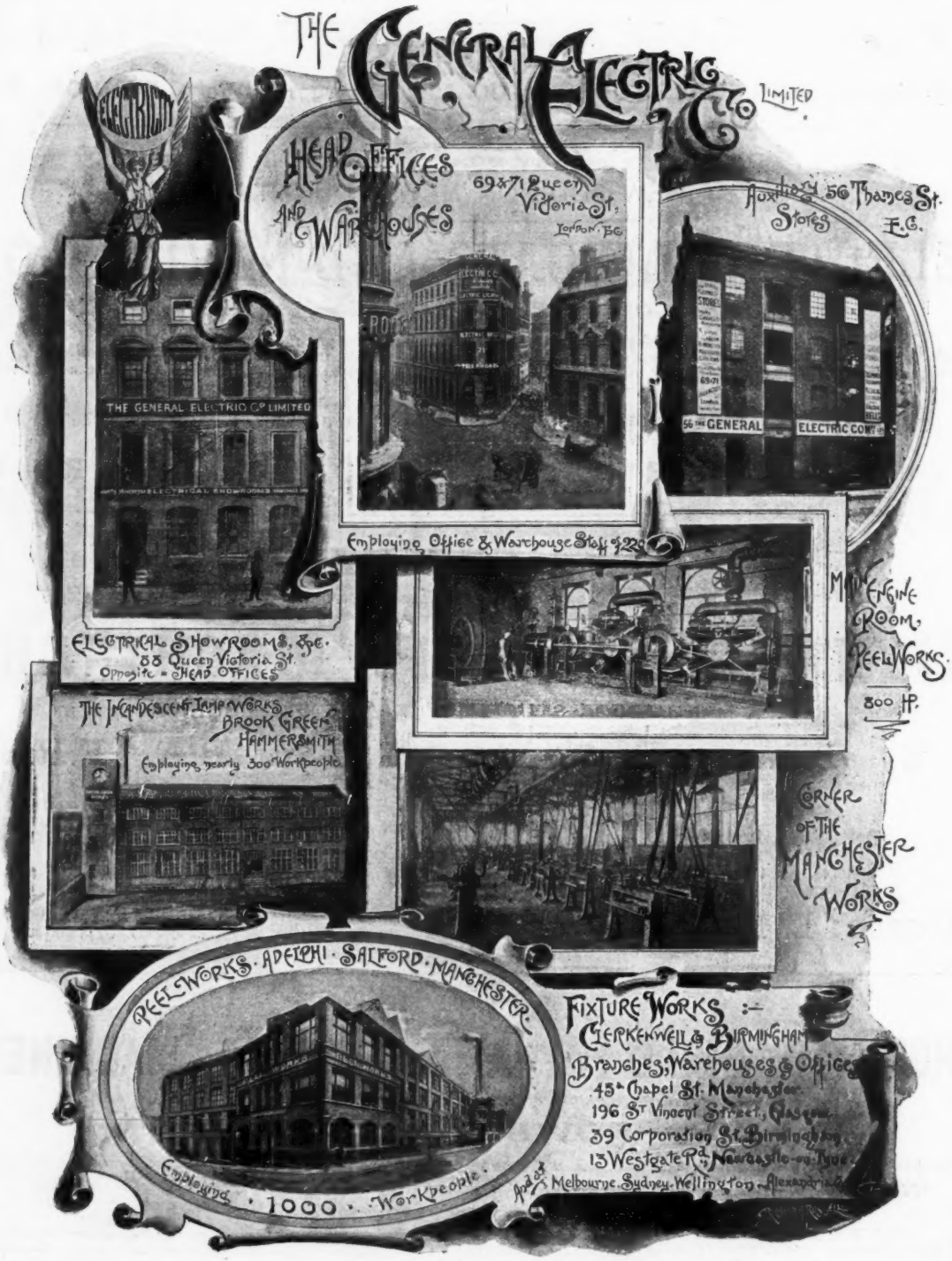
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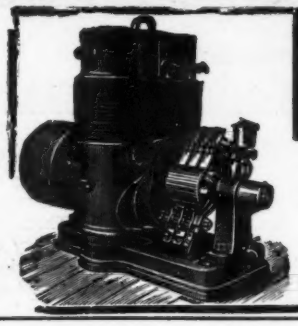

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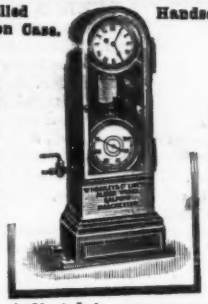

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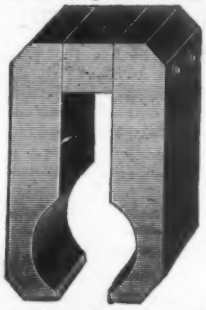

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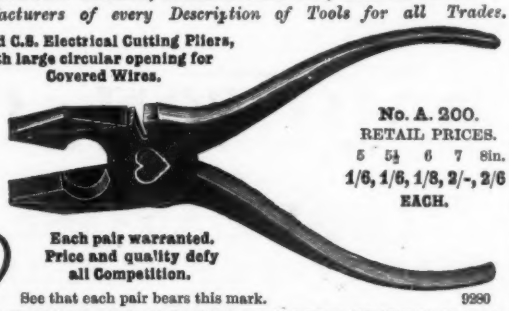

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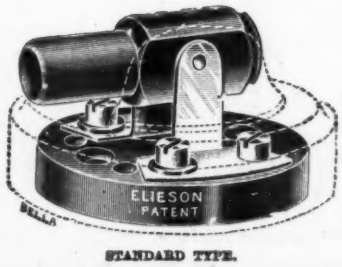

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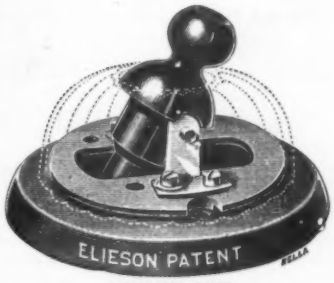

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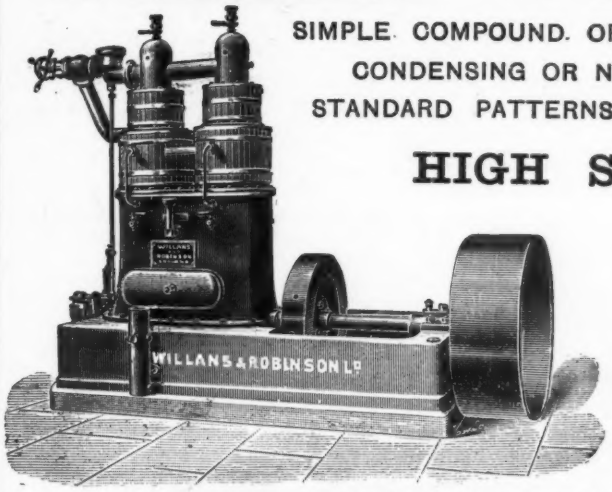

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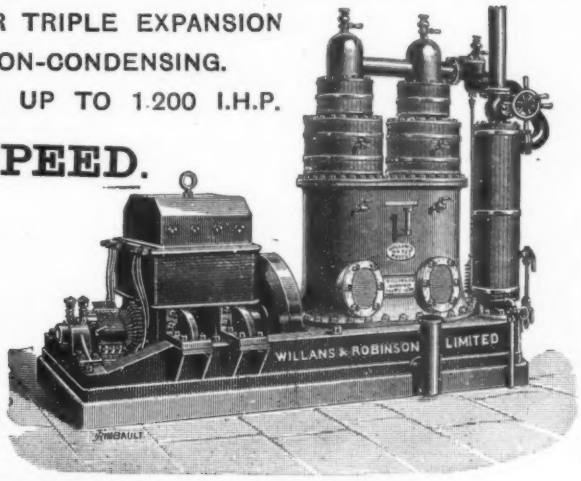

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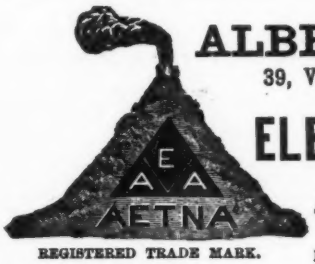

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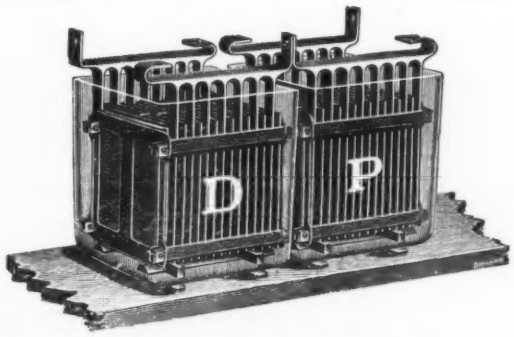

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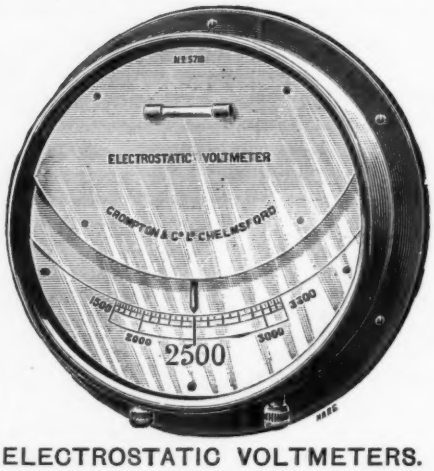

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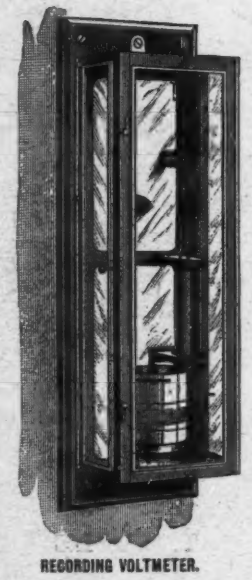

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WORKING WITH PERFECTLY SATISFACTORY RESULTS.

GLASGOW.

Corporation (after over 2 years' experience):
THERE IS NOT ONE INSTANCE IN WHICH THEY HAVE FAILED.

MANCHESTER.

Corporation (after nearly 2 years' experience):
NOT ONE INSTANCE IN WHICH THEY HAVE FAILED.

DUNDEE.

Corporation (after over 2 years' experience):
NEVER HAD THE SLIGHTEST TROUBLE.

DUBLIN.

Corporation (after over 2 years' experience):
NO FAULT WHATEVER HAS OCCURRED ON ANY CABLE.

LEEDS.

(After over 2 years' experience):
NO FAULT, AND CABLE QUITE SATISFACTORY.

BLACKPOOL.

(After nearly 2 years' experience):
NO FAILURE OF THE CABLES.

OXFORD.

(After nearly 3 years' experience):
AS GOOD AS THE DAY THEY WERE PUT DOWN. NO TROUBLE WHATEVER FROM THEM.

WOKING.

(After over 3 years' experience):
COMPLETE SATISFACTION; NO SIGNS OF DEPRECIATION.

NEWCASTLE & DISTRICT ELECTRIC LIGHT CO.

(After over 5 years' experience):
QUITE AS GOOD TO ALL APPEARANCE AS THE DAY WHEN THEY WERE LAID UNDERGROUND.

Special Cables can be Tested up to 20,000 Volts.

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